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INFLATION AS A FARM RELIEF MEASURE

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It has long been recognized that the most serious weakness of modern economic life lies in the fact that it is subject to sudden and drastic changes in price levels. The mere fact of price change has not been considered either a weakness or an evil. On the contrary changes in price have been regarded as the very essence of the economic system under which we have lived, since rises and falls of price have served as automatic indicators to both producers and consumers. They have shown when to produce or not to produce, when to consume or not to consume. Briefly, price changes have served, consciously or unconsciously, as the very motivators of economic existence. But to serve these purposes, changes in price must be gradual, must be small enough and slow enough to permit all parties to make the necessary adjustments without serious economic inconvenience. Such changes are the normal ones, the growing pains, made necessary due to the fact that we are dynamic people living in a dynamic world. Instead of creating problems for us they are supposed to act as an automatic steering-gear keeping us on the straight road of steady economic progress.

It is quite different with those sudden and drastic price changes which constitute the outstanding characteristic of what we know as business cycles, or periods of alternate depression and boom. During such periods whole sections of the population may be rendered bankrupt almost overnight and without warning; the hard-earned savings of a lifetime may suddenly evaporate; independence may have to give way to charity; all debtors, including the governments, are certain to encounter financial embarrassment; unemployment may become the rule; and standards of living for many will scarcely exist. These severe attacks which periodically afflict the body economic have been rightly regarded as our most treacherous economic disease. Furthermore, as is the case with many diseases, each succeeding attack has proven vastly more severe, so much so that grave fears have been experienced lest the patient eventually succumb. It is because of this that our economic doctors have spent so much energy in the post-war period trying to discover the causes of business cycles and to effect a cure therefor. Many diverse explanations have been offered and as yet no very great degree of unanimity has been reached among the special students of the problem. In justice to the economic doctors, however, it must be said that the remedies or preventatives so far advocated have not been given a thorough trial due to the reluctance of the patient to submit to the treatments. This, in turn, is due partly to the fear that the remedy proposed might prove more harmful than the disease itself, but chiefly to the fact that the collective patient,

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that is, the economic world, has not been able to decide whether or not it was really sick enough to consult any doctor. There are sections of public opinion which believe that business cycles are inevitable and uncontrollable, sometimes of prolonged severity, but never absolutely fatal. This view is based on history and on the belief that history must repeat itself. It is a mixture of blind faith, fatalism, and optimism. There are other sections of the public which, because they find their economic lot improved by sudden price changes, are more than content to leave things alone. But there are still others whose economic suffering is so intense that they would more than welcome anything which might relieve the pain even if it might not effect a permanent cure. If they must suffer an economic death it must be as painless as possible. They stand in marked contrast to that element which prefers to die rather than diet.

Among the many explanations of the present depression we may include the claim that it reflects a moral collapse, is due to unlimited human greed, an undue emphasis on a crass materialism, a belief that one can get something for nothing if he only will. This diagnosis implies that the remedy must be a universal rise in the ethical standards of business, a veritable religious earthquake. Some again say the depression is due to overproduction or to underconsumption or to overspeculation. Some say it is psychological in character, there being too much optimism followed by too much pessimism. But among all the explanations the one which has received most attention of late is the claim that the depression is a purely monetary phenomenon. There is, in fact, no clear line of division between those who offer a monetary explanation and those who suggest overproduction, underconsumption or overspeculation as the cause, since overproduction can occur only if too much money has been provided, underconsumption if too little money is in the hands of consumers, and overspeculation if the money was used for other than its normal trading purposes. It is, no doubt, the pronounced drop in commodity prices which, to the average outsider at any rate, lends weight to the conclusion that somehow or other this great depression, or if you prefer, this tremendous drop in prices, is due to insufficient money. Since prices are supposed to be the resultant of the division of the monetary supply by the volume of trading and since the volume of trading surely has done anything but increase, then must not the low prices be due to a greatly reduced dividend or monetary supply?

Presumably it might be almost as logical to argue that a lack of money is a *result* of the depression as to say it is the chief *cause* since the latter claim requires evidence that a monetary scarcity existed at the time the depression began. Whether it be possible to prove this or not it is not our purpose to discuss here and now. All we desire to note is that there is a widespread belief to-day that this depression is due chiefly to an insufficient supply of money and that all that is needed to end it is to increase the monetary supply. Those who take this stand are out-and-out inflationists, that is, they want to blow or pump more money into the economic system. Whether this means reduction of bank interest rates, gold revaluation, or the starting of the government printing presses, the end aimed at is the same—an increase of the monetary supply. Monetary inflation means increasing the supply of monetary media as a means towards steming a price fall or bringing about a price rise or possibly both. Without attempting

either to substantiate or criticize the monetary explanation of, and the inflationist cure for, the depression and without any attempt at deciding the vexed question as to whether this is 'just one more' depression or the end of an economic system, we wish to offer some comments regarding the origin of the recent demand for inflation as a farm relief measure, the various forms which inflation in Canada might take, and what effects it might have on the economic well-being of our farmers. In doing so we are fully aware that many of our advocates of inflation are by no means thorough-going inflationists in the sense above described, but merely see in inflationary measures a stop gap, a breathing spell, a sedative that might partially relieve the pain of this extremely sick patient while waiting for history, or world conferences, or acts of God to supply the real cure.

Whatever the more distant or deep seated causes of the depression may be, no farmer and no student of the agricultural industry needs to be told the *immediate* causes of the farmers trouble. It is but too well known that most of the farmers' costs are of a long-time fixed nature, that the fixing of these costs took place before the depression set in and price levels began to fall and on the full expectation that the prices of farm products then ruling would continue during the years when the costs would have to be met. It is obvious that this expectation has not been fulfilled and that as a result it is utterly impossible to meet the fixed interest and principal payments and the fixed insurance charges and ever-growing tax bills out of a farm revenue almost vanished because of the drop in farm prices. It is also clear that in the general fall of commodity prices, farm commodity prices have fallen much faster and farther than either wholesale or retail prices. This unevenness in the rate of fall has meant that the farmer's purchasing power in terms of those goods which he must continue to buy has continued to fall.

What are the possible ways of escape from this predicament? There would seem but two. One is to bring about a reduction in the fixed costs so as to counteract the drop in farm prices. This would mean reduced taxes, downward revision of debt contracts, etc. No doubt a considerable cost reduction of this sort has taken place already or is under way. Mortgage companies, farm machinery manufacturers and other large creditors, deciding that half a loaf is better than no bread, are being compelled to reduce interest and principal payments in increasing numbers of individual cases. Whether governmental action to compel alteration in purchase agreements and lending contracts will occur in Canada remains to be seen. In Australia, where farmers are fairly powerful politically, the precedent for such action has been well established, while in the United States a gigantic government measure to reduce interest rates on farm mortgages is being legislated through as we write. At any rate it is a matter within the jurisdiction of Canadian authorities since our farmers' debts have been incurred and are payable at home.

But even if nothing is done to reduce the burden of fixed costs, there may still be a possibility of easing the pressure by virtue of the expedient of raising farm prices. This is where we enter properly upon the consideration of inflation. In order that prices of goods may rise one of three things must happen. The supply of goods must fall, the desire for goods must rise, or the amount of money available as purchasing power must increase. Despite occasional statements to the effect that supplies of farm products should be curtailed, Canadians thus far seem to believe that nothing short of utter

bankruptcy or the intervention of a particular brand of weather can do anything about it. We seem quite content to watch and see what happens to the voluntary allotment plans in the United States before interfering in any organized fashion with supply here at home. As for demand, we are forced to witness the growth of a world-wide policy of self-sufficiency in the matter of food supplies, even Great Britain, our chief reliance as a foreign market, being virtually compelled to follow reluctantly the general trend. There is an ever-keener competition for a market growing constantly more limited. And despite any protection which tariffs may give, our domestic consumers of agricultural goods still have the desire to buy but in many instances lack the paying ability to back it up, and since it is desire plus ability to pay that constitutes effective economic demand, such demand as does exist means low prices. The person who says there is just as great a demand for food as ever and that this must be so since people must live is correct if properly understood. There is a demand at a certain price. But that price is a very low one. It is in order to raise it that inflation is being advocated. The inflationist is saying in effect: there is no overproduction of farm products, neither is there any lack of desire for those products; what is lacking is a supply of purchasing power sufficient to make that desire result in a really effective economic demand and therefore a satisfactory farm price.

Proceeding on this general thesis the inflationary advocate's next step is to decide upon the particular form which inflation should take. The nearest to orthodox way would be to declare a reduction in the bank rate, that is, the rate which the central bank charges ordinary commercial banks when it rediscounts their paper securities. The commercial banks could then pass on to their customers a corresponding reduction in interest rates. Such a reduction would act as a direct stimulus to borrowing, the extra borrowing would mean extra money and so inflation would be an accomplished fact. Such a method, however well it might function under normal business conditions, must be ruled out at the present time. To begin with we have no central bank in Canada although the Federal Finance Department under the terms of the Finance Act might continue to act as a substitute. But the real trouble is that business confidence is absent at present, and when such is the case neither lenders nor borrowers are keen to act. A second plan would be to carry on open-market operations, a method very considerably used in the United States in recent years. It means simply that the government goes into the open or public market for securities, chooses certain relatively safe securities, buys them and issues new money to pay for them. It buys the securities not because it wants them but because it wants to get new money equal to their purchase price into circulation. This method is unworkable here due to the absence of any open security market, something which requires some time to develop. Another conceivable plan would be for the federal government to print new currency based on the security of our natural resources and use it to meet ordinary public expenditures in lieu of tax returns. The taxes could then remain unpaid and would constitute that much extra money usable for other than tax-paying purposes, among others the purchase of farm commodities. As a matter of fact this was the method employed last November when inflation to the extent of $35,000,000 took place. The Federal government, finding itself in need of that much money, went to the banks and applied for a loan. The banks took the

government's treasury notes as security, discounted them at the rate of 4% and made a credit entry in favour of the government to the extent of $35,000,000. But since treasury notes of the federal government rank among the types of securities which the banks can offer for rediscounting under the terms of the Finance Act, the banks promptly took these notes back to the federal treasury and asked the government to rediscount them. This the government did, charging 3% discount and giving the banks large denomination Dominion notes in payment. But according to the Bank Act these latter notes may form part of the bank's cash reserves. By this means, therefore, the government secured the money it required at 1% interest, and the banks added thirty-five millions to their cash reserves thereby placing themselves in a position to extend extra credit to ten times that extent should it be called for. (The fact that it has not been called for is proof of the futility under present conditions of the first-mentioned method above.) No new legislation or financial machinery was necessary. It would seem that the only real limit to the use of this method is set by the government's unwillingness to inflate or to mortgage the country's natural resources.

All of the above-mentioned methods would have as their primary purpose the raising of the domestic price level and would influence exchange rates between countries only indirectly. This is worth noting since thus far rural interests with inflationary tendencies have urged that the Canadian dollar should be depreciated until it reaches a par with the pound sterling. In other words they want the exchange value of the Canadian dollar reduced until one English pound will exchange for $4.87 instead of for $4.11 as at present or for around $3.70 as has been the case during most of the past winter. For these people, therefore, inflation means depreciation of the Canadian exchange rate to a par with the pound. How might this depreciation be effected? To answer this it is necessary to note what it is that determines the rates of exchange between countries. The briefest explanation of this is to say that the prices or rates of foreign exchange are determined in the same general way as the prices or rates at which ordinary commodities exchange, namely, by the interactions of supply and demand. The stock-in-trade of international exchange dealers consists of bills of exchange and these in turn, are the media of settlement for international obligations. Every payment due to foreign governments or individuals represents a demand or foreign bills of exchange, and, of course, the greater the demand for them the higher their price, that is, the rate of exchange. From this it may be assumed that any increase in Canadian obligations abroad will mean an added demand for foreign bills of exchange and that this demand will show itself in the form of a higher price offer, more Canadian dollars being offered for the bills of foreign countries. When that happens we say that the Canadian dollar has depreciated in exchange the reason being that a single dollar is now worth less in exchange than before.

In order to depreciate to parity with the pound, as has been urged, several alternative systems are available. One suggestion is that the government proceed to appoint a special board to be known as the exchange stabilization board. This body would begin by buying up a quantity of foreign bills of exchange which could be kept on hand and sold later at intervals when such action was necessary to keep the exchange rates stable. Not only would this supply of foreign exchange serve as the stabilizing fund,

but its very purchase would go part way towards bringing about the initial depreciation required. To effect the balance of the depreciation the government might, let us say, buy Canadian bonds held in the United States or Great Britain or it might pay off any loans maturing in New York instead of postponing their payment by means of reborrowing. The purchase of the foreign exchange and the bonds and the paying off of the loans would increase the government's foreign committments in precisely the same way as the importing of goods would. In every case the government, in order to effect a settlement, would have to purchase foreign exchange and the question is, where would it find the funds to do so? The answer of the inflationist is, let the government supply new money either by printing its own Dominion notes or by obtaining fresh borrowings from the banks after the method already mentioned. Thus we see that bringing the dollar to parity with the pound must involve the government in inflation. Indeed it must be clear from all we have said that any attempt to bring about inflation at the present time must devolve upon the government since banks cannot and will not increase the supply of currency and credit on their own initiative in the absence of general business confidence.

Assuming, however, that inflation is quite possible of realization, our really prime concern in the present article is the extent to which it would prove beneficial to Canadian farmers. It is no mere accident that our farmers should be the class evincing keenest interest in inflation and particularly that they should favour the special type indicated by 'parity with the pound'. Since our farmers must sell a very large proportion of their products abroad and particularly to Great Britain, they are vitally concerned as to the number of Canadian dollars they will get when the pounds of the British purchasers of their goods are transferred into Canadian funds, the only funds of any use to themselves. Concretely it matters much to them whether an English pound will yield them \$3.70, \$4.11 or \$4.87. The reason for this concern is that their long-time fixed costs, the present cause of their worry and embarrassment, are payable in Canadian dollars. Whether those dollars are inflated or not it matters not to them since their debt contracts merely state that so many Canadian dollars are payable at a certain time. Hence any depreciation of our exchange, since it means more dollars to exporters, will find favour with debt-owing farmers. Incidentally it is frequently asked why our exporters outside the farming ranks have remained so comparatively indifferent regarding inflation. The reason is that while it is true that such people would receive more Canadian dollars for goods sold, these extra dollars would be of little if any value since their debts have been incurred abroad and are payable in foreign money. It is, of course, still easier to understand the opposition to inflation of Canadian manufacturers. Selling their goods in a protected Canadian market for the most part and owing debts on capital account outside Canada, they stand to gain nothing on the income end and to lose heavily on the expense end.

Now while it is perfectly obvious that a farmer exporter stands to gain through inflation in the manner outlined above, it is not at all clear to us that he will benefit to anything like the degree that many sponsors of the idea estimate or claim. Without belittling in any way the benefits to be derived from inflation it seems advisable to draw attention to some of what might prove to be rather serious limitations. To begin with not all of our farmers

are exporters and not all of our farm commodities are on an export basis. What benefit for example would be derived by a farmer living in the vicinity of Montreal or Toronto and specializing in whole milk production? Here is a commodity consumed locally which fact prevents the producer from receiving any exchange advantage. It might be replied that while whole milk is not on an export basis cheese is, that milk can readily be made into cheese if there is any worthwhile price inducement, that since cheese is so largely exported cheese patrons will gain that inducement through exchange, and that, seeing this gain whole milk producers will at once send their milk to cheese factories. No doubt many who are now sending whole milk long distances have cheese factories in their vicinities and could therefore transfer patronage readily. If so they would relieve the pressure on the whole milk markets and allow the price of whole milk to rise to the benefit of those producers who live in distinctly whole milk producing areas where cheese factories no longer exist if they ever did. But it is scarcely possible that new cheese factories would be erected to handle milk in such areas and still less likely in the prairie provinces where cheese-making has always for good reasons been conspicuously absent. Not only might capital be lacking and the benefit to be derived doubtful but it would require some little time, whereas inflation is to give relief here and now. But whatever might result in connection with the dairy enterprises, it seems clear that producers of such commodities as small fruits and vegetables (which at present, because of the tariff, includes potatoes) could not hope for any immediate or direct gain since they must sell their products in the Canadian market. We do not say that no benefit whatever would come to such people but merely that it would not likely be either direct or very immediate. Indirectly they would benefit because of benefits more directly conferred upon others. It might come about in some such way as this: wheat growers would get more dollars because of exchange depreciation; with these extra dollars they might buy potatoes instead of growing them, or satisfy a long-denied craving for strawberries; if not they might pay a bill due an implement manufacturer; that company might soon be able to hire a few more men who before long would have both an appetite for fruit and vegetables and the money to pay for them. So in the course of time even these farmers would probably derive a benefit. But they must not expect any very immediate relief. That would presuppose an early rise in the general Canadian price level which is not to be expected, and incidentally, should it occur, farmers would at once incur the disadvantage of having to pay more for those things which they must continue to buy.

The next fact worth remembering is that our farmers are not only exporters but very considerable importers. If exchange depreciation would prove an advantage when exporting, it would prove a disadvantage when importing and for the same reason. The lowering of the exchange rate of our dollar would have the same effect as the raising of the tariff so far as all importers were concerned. It is likely that some goods at present imported could and would be obtained at home but there are others of a character highly necessitous to farmers that must continue to be imported. Those of our farmers who must burn coal or use gasoline will realize this. On balance, however, this disadvantage due to importing would not be so very great. To offset it is the fact that exchange depreciation, acting as an addition to the tariff, would help to protect certain Canadian farmers from the com-

petition of such things as New Zealand and Australian butter and United States and South African fruit and vegetables. It is also conceivable (but somewhat unlikely) that the tariff rates would be lowered to offset the increased cost on exchange. All one can say is that the means exists.

There is, however, another way in which the increased cost of importing might tend to limit the benefits of inflation. To whatever extent Canadians of all classes curtailed imports they must expect a greater difficulty when it comes to exporting. It seems to be more or less assumed that should Canada adopt inflation the prices received for farm products abroad would remain at least as high as they are today. It is by no means certain that such would be the case. What, after all, determines the level of, let us say, the world price of wheat? Among other factors it can hardly be denied that the amount of purchasing power in the countries making up the demand for wheat is most important. Now the amount of this purchasing power, in turn, is affected very considerably by the funds received as payment for commodities exported. The money which Englishmen have to spend on wheat, for example, represents to a great degree the receipts for manufactured goods sold by England in countries like Canada. If then Canada imported less of such goods, England would have less money with which to buy Canadian wheat, and the result of this would be that the world price of wheat would have to go down somewhat. If this price is measured in English pounds we might be faced with the spectacle of an English pound being worth more Canadian dollars than at present, but also of there being fewer English pounds available for transference into Canadian funds. How important this limitation would be can only be guessed at, but that it would tend to exist is certainly quite evident.

Then again the statement has been made regularly that if we had parity with the pound Canadian farmers would be in a much better position to sell products abroad. The implication seems to be that since exchange depreciation would give our farmers more dollars, the farmers in turn could afford to take lower prices for their goods in terms of foreign monetary units and could therefore unload more of their present alleged surplus. All that one can say to this is that to whatever extent Canadian farmers were willing to take lower prices they would be transferring at least part of the supposed benefits of inflation to the importers. And certainly if they tried to increase sales very much the increased supplies on the foreign markets would bring about lower prices there, and therefore accentuate the price drop due to the lessened Canadian importations already mentioned. On the other hand it cannot be denied that the mere fact of exchange rates being stable should result in somewhat higher prices to the farmer. Since the exporting agents would not have to incur the risk at present associated with fluctuating exchange rates they should be able to operate on a narrower margin and to allow this saving to go to their farmer customers in the form of somewhat higher prices.

It is difficult, if perhaps not impossible, to estimate with any degree of mathematical exactness the various limitations to inflationary benefits thus far noted. It is not so with a further limitation which may now be considered. It is a fairly obvious fact that the degree of inflation must itself set a limit to the benefits to be derived therefrom. As already stated most advocates have suggested that we stop inflating when the dollar has depreciated to parity

with the pound. True some have asked for more than this but as many have asked for less. Assuming this amount to be granted, to what extent will it tend to offset the present low price of farm products, for it must never be forgotten that the whole plan is designed to raise prices? The difference between \$4.11 and \$4.87 is approximately 15%. Fifteen per cent added to the present price of a bushel of wheat or a pound of bacon or cheese still leaves a long distance to go before covering the average cost of production even though all thought of profits be disregarded. It would appear that, in order to allow the farmer to break even, a far greater price rise than any practicable amount of inflation could give would be necessary. This is not to deny the benefit of a 15% rise over present price levels (an amount rendered most doubtful when the other limiting factors mentioned are considered) but merely to emphasize that inflation as at present advocated could neither usher the farmer around the prosperity corner nor lift him out of the sea of debt. Neither is this an argument for a greater measure of inflation than that being asked for. Rather is it evidence of the fact that, though inflation of a given brand and amount might lift part of the burden from off the farmer's back, it will require something far less palliative and more fundamental in character to render agriculture prosperous.

By way of concluding our remarks it seems reasonable to say that the question as to whether the continued drop in prices can be curbed and reversed by putting more money into circulation is closely related to the question as to what extent the said price drop has been due to insufficient money, and that in any case any attempt to dispel the depression by inflationary means is something calling for concerted international action. It is also apparent that inflation is, like the tariff, a game at which any number of nations can play and one in which the competition may becone equally suicidal. It is even conceivable that any benefits already derived by certain countries from inflating may be due to the fact that other countries have refrained from similar action thus indicating that the advantages of inflation are temporary and competitive in character. At the same time, considered as a short-run relief measure, inflation in the form and degree ordinarily proposed in Canada would probably result in some real advantage to our farmers since it is an indirect way of lightening the fixed costs of debtors, including farmers, by giving them higher prices to offset those costs. But since the extra price would be such a small fraction of the price fall to date it seems clear that only a correspondingly small fraction of relief would result.

Two final comments should be made. In the first place the recent rise in exchange from \$3.80 to \$4.11 has at least partially eliminated the case for inflation. The more it continues to rise the weaker becomes the inflationary argument. In the second place the 1933 federal budget proposal to assure exporters of certain farm products \$4.60 for a pound sterling may be regarded as a possible and modified alternative to inflation. It is modified, first, because it offers only \$4.60 and not the \$4.87 demanded for a pound, and second, and still more important, because it is to apply to eight commodities only and generally speaking those which are exported in small quantity. Commodities like wheat and apples which are exported in very large quantities are specifically excluded from the plan. The smaller the amount of a commodity exported the smaller the sum needed to pay the government bonus.

Conversely commodities exported in large quantities would require correspondingly large sums for the bonus payments. It is probably because the Federal government could not procure funds enough (that is, not without having to resort to open inflation) that it has seen fit to exclude expressly from the plan those of our farm products which are exported in any considerable quantity. In view of the present tendency of the pound to rise, however, and in spite of the present limitations to government borrowing, it is altogether probable that funds enough to pay the bonus on the eight commodities selected will be found without the government taking any inflationary steps. Indeed, if the pound continues to rise in terms of dollars, even more commodities might be included without unduly burdening the government. It must not be forggtten, however, that the burden on the government treasury will in this case vary directly with the degree of government benefit conferred upon the farmer.

SURVEY OF THE FORAGE CROP SEED SITUATION IN THE PRAIRIE PROVINCES OF CANADA[1]

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The farmers of the Canadian prairie provinces have during the past two decades directed their efforts chiefly towards the production and export of wheat. Economic and other circumstances until recently probably warranted wheat farming as the major agricultural interest, but conditions have changed and now wheat farming yields little profit. Farmers are therefore turning much attention to livestock production and its co-requisite forage crop farming. This move has been largely forced not only by economic conditions but also by such other conditions as extensive weed infestation, soil drifting and reduced yields. As a result of this greatly increasing interest in forage crops the problem of seed supplies has become a matter of considerable concern. The prairie provinces and indeed all Canada have in the past imported large amounts of forage crop seeds, although our agronomic conditions are quite suitable for the production of most of our requirements. This situation has led me to the conviction, and this is my thesis on this occasion, that forage crop seed production should be very appreciably increased in these provinces, at least to the extent of supplying our own increasing requirements, in so far as this may be economically practicable. By growing our own seeds we can be assured of supplies of hardy and approved suitable varieties. Further, we can avoid sending large sums of money outside the provinces for imported seeds, and so increase the incomes of our farmers who undertake to produce these seeds for us.

It is actually the case that the prairie provinces produce, in relation to their area and suitability for grass production, a smaller amount of grassland products than any other similar area in the world. The ill effects of farming without grass—producing cereal crops interspersed with bare fallows—is patent to all observers. Weed and soil problems together with economic conditions that need not be discussed now render it imperative that the prairie farming system be changed and that larger areas of forage crops be grown.

A comparison of grasslands of Canada with those of other countries is difficult to make but a very fair idea of where we stand may be gained by comparing our exports with those of other lands. In such comparison we find that Canada lags far behind many countries in the values of the grassland products she exports. By grassland products are meant those that result principally from grazing and from the feeding of forage plants, that is, dairy products, meats, etc. It must also be remembered in such a comparison that Canada does export more cereal grains than many other countries and due discount must be made for this. Yet the comparison is of value in that it shows relative positions.

McConkey (*1*) is authority for the following figures: he states that grassland products comprise:

94% of the total exports from New Zealand,
60% of the total exports from Australia,

[1] A paper presented at the twelfth annual meeting of the Western Canadian Society of Agronomy at Winnipeg, Canada, June 16th, 1932.

[2] District Inspector of Dominion Seed Branch for Alberta and British Columbia.

55% of the total exports from Irish Free State,
41% of the total exports from South Africa,
17% of the total exports from Canada.

Further it is stated that 64% of the total agricultural production of England and Wales is derived from grassland.

While conditions differ in all these countries we must admit that Canada lags far behind in production of these products. We must admit further that Canada can produce these products as successfully and of as high quality as can the other Dominions named.

This paper presents data concerning Canadian imports and exports of forage crop seeds, and the extent of our present seed growing industry. Seed requirements and certain other matters pertinent to the further development of this industry in the prairie provinces are discussed.

Canadian Imports and Exports (*2*)

A brief survey of the import and export trade of Canada as a whole will serve to show briefly just what Canadian grass seed needs are.

From the standpoint of actual quantity of seed brought in, timothy stands at the top, although this is one crop that can be produced especially well within the Dominion, and has shown itself well adapted to parts of Alberta. During the years 1925 to 1931, Canada imported an average quantity of timothy seed in excess of 7,000,000 pounds. This influx of timothy has been reasonably constant and has shown no tendency to decrease during the period. In fact the contrary appears to be the case, for over 8,000,000 pounds were imported in 1930 and 9,000,000 in 1931. Over 10,000,000 pounds of this seed are used annually in Canada. Recent tariff arrangements by which a duty of two cents per pound was put on timothy seed imports into Canada have stimulated the Canadian timothy seed-growing industry and will be of great benefit.

Second to timothy in quantity imported is red clover seed. The average amount brought in during the last seven years has been 1,600,000 pounds. In 1927 the amount imported was over 3,000,000 pounds and in 1930 well over 2,000,000. The consumption of this seed is heavy in Canada, though it is not used much on the prairies. In 1929 Canada used over 5,000,000 pounds and in 1930 just under 4,000,000. It is pleasing to note however that during 1931, this crop did particularly well within Canada and a quantity was exported to the British Isles, where it has met with recognition as very desirable seed, and the foundation has thus been laid for further export trade.

Canada is self-supporting in so far as alfalfa is concerned, although nearly 500,000 pounds were imported in 1929, while 200,000 pounds were exported in 1930. During past years, however, considerable alfalfa has been exported in excess of imports. The apparent consumption in Canada was slightly over 1,000,000 pounds in 1929 and 4,250,000 pounds in 1930. No other seeds are imported in quantity.

Among the exports of forage crop seeds from Canada, alsike clover takes the lead. For the past seven years the average export has been 7,500,000 pounds. This has been sent almost wholly to the United States and has had of late years to enter that country against a duty of eight cents per pound.

Canadian blue grass is the only other grass that Canada has been exporting in important quantities.

Thus we see that within Canada there is need for much greater production of seed in order to fill the present demands of our own market.

Forage Crop Seed Requirements in the Prairie Provinces

Some reference may here be made to the extent to which forage crops are grown for fodder purposes in the prairie provinces, to the possible increase in forage crop production and incidentally to increased seed requirements. Of the actual seeded area in the prairie provinces we find that a very small proportion indeed is seeded to grass either for hay, pasture or for seed production.

For several years past the province of Alberta has had approximately 10,000,000 acres of land actually seeded to crop each year. The average area over the past five years that has been seeded to grass or legumes (forage crops) has been 283,000 acres. The area so seeded reached the high point of 374,000 acres in 1931. Thus we see that the acreage in forage crops for the past five years has been less than 3% of the entire seeded area, and even in the high year of 1931 less than 4% of the land seeded and growing crop was in forage. These figures do not, unfortunately, tell the whole tale for they do not take into account the area that was tilled but, being fallowed, did not grow a crop. When we compare this small proportion with Great Britain with over 70% of its tillable area in grasslands the contrast is very striking.

In 1930 Saskatchewan had a total seeded acreage of slightly over 23,000,000 acres and of this, according to figures provided by the Field Crops Department of that province 875,000 acres or approximately 3.8% were seeded to grass. Of this amount nearly half was pasture so that slightly over half, or 456,000 acres were devoted to hay and seed production. Thus 1.96% of the total seeded acreage was devoted to hay and seed production; the actual acreage harvested for seed alone has not been ascertained. For the year 1931 the figures for this province are all slightly lower and so, unfortunately, are the percentages in grass. During the last year the acreage seeded was slightly over 21,500,000 acres. Grasslands amounted to 3.4% of this, or 1.75% of the total seeded acreage was devoted to hay and seed production. Had it been possible to work these figures out as the proportion of the total cultivated area the percentages shown in grass and hay would have been appreciably smaller.

In the province of Manitoba corresponding figures have not been procured. That a very similar condition prevails there is shown in the results of a survey of fifty school districts in ten of the fourteen crop districts of this province. In these districts a total of 1,278,592 acres was cultivated. Of these 47,914 acres were seeded to forage and fodder crops, but these included such crops as corn and sunflowers. However this shows that the area seeded to crops of this nature was 3.75%. This corresponds to the figures that were arrived at for the other provinces and leaves the inference that less than 4% of the total seeded acreage each year is devoted to forage crops over the three provinces. This, it must be admitted, is a very small proportion of the farming land to be devoted to grass production.

It is very difficult to estimate what proportion of our area should be devoted to grass. I think, however, that most agriculturists who have studied this question would agree that a much larger proportion of our seeded acreage than at present might profitably be seeded to forage crops, except in a few parts where grass, although vitally needed, is very difficult to grow because of very dry conditions. I am thus contending that, in view of all the circumstances, the three prairie provinces might well, and in all probability will, increase very materially their acreage of grasses and legumes. It would appear reasonable to assume that not less than four times the present grass acreage would be desirable.

To provide for such an increase much more seed than is now grown would be needed, and added to this is the seed required for reseeding large areas of range land which have been overgrazed in dry seasons until a great part of the natural grass vegetation has been destroyed. There is also a good deal of abandoned land on the prairies, which, to become productive, must inevitably be reseeded to grasses sooner or later. These circumstances all point to demands for much more grass and legume seeds than have been required in the past.

Forage Crop Seed Production in the Prairie Provinces

In regard to seed production within the three prairie provinces the following statistics may serve to convey some impression of the quantities of different kinds grown recently. I am indebted to the Market's Division of the Dominion Seed Branch (2) for these figures which are as nearly accurate as the representatives of the Seed Branch have been able to secure and are certainly very nearly correct.

The kinds and amounts of forage crop seeds produced in 1931 are as follows:

Alberta	
Sweet clover	1,000,000 lbs.
Timothy	125,000 "
Alfalfa	228,000 "
Brome grass	110,000 "
Western rye grass	50,000 "
Alsike clover	33,000 "
Red clover	15,000 "
Saskatchewan	
Sweet clover	500,000 lbs.
Brome grass	475,000 "
Western rye grass	170,000 "
Manitoba	
Sweet clover	2,375,000 "
Brome grass	30,000 "
Alfalfa	15,000 "

These figures indicate that appreciable quantities of these seeds were produced in 1931, but the total amount which is 5,126,000 pounds is sufficient to seed only about 520,000 acres. This amount of seed is therefore not enough for more than one-third of the acreage that is seeded down at the present

time. It is certainly very far from adequate for the increased acreage of forage crops, which should be encouraged in these provinces and which indeed seems inevitable.

When we consider the high quality of the seeds that can be and are produced by the relatively few growers who are trying to produce good seed, we see that we are neglecting a golden opportunity. The premier prizes taken by grass and legume seeds from western Canada at the recent Royal and International shows are yet fresh in your minds and need not be enumerated. That part of Canada that has shown itself capable of producing the best forage crop seeds on the continent is producing but a fraction of what it should use itself.

It is possible that so far I have sketched a rather gloomy picture of the conditions that prevail as regards grass seed production, for I have endeavoured to show that the amount produced is far below the needs of the provinces themselves. There are, however, hopeful signs regarding grass seed production, which are brought out in the work of the Dominion Seed Branch. By comparing the numbers of field inspections that we have made during recent years and the numbers of samples that have been sent in for analyses by farmers to our laboratories, it is evident that many more people are commencing to take an interest in grass seeds.

In Alberta we have analyzed the following numbers of samples. Figures are shown for the past two seasons and for 1927, five years ago, for comparative purposes.

Kind	*1927-8*	*1930-1*	*1931-2*
Brome	32	50	159
Sweet clover	36	66	105
Western rye grass	17	9	31
Alfalfa	117	124	131

These figures show plainly that there is an increasing interest in grass seed production and that growers are taking a much wider interest particularly during the last two years.

The map accompanying this paper will serve to indicate the locations and extents of districts in the prairie provinces where the different kinds of forage seed crops have been grown.

We noted that the province of Alberta had produced approximately 1,000,000 pounds of sweet clover seed. This crop does well over the entire province and does not need particular stimulation from the standpoint of seed production. The three individual areas that have produced the largest amounts of seed are the irrigated lands at Brooks and Lethbridge and the district around Athabasca.

With alfalfa Alberta has perhaps achieved the greatest success, and most of the western-used seed of this crop is grown in this province. While small amounts of the seed are produced at scattered places over much of the province the bulk of the production centres about Brooks. Here under irrigation the crop has been very successful. A large proportion of the seed grown is of known ancestry and reaches the market sealed as registered seed. The bulk of the trade is handled by an organization known as the Grimm Alfalfa Seed Growers' Association of Alberta which has its head-quarters

and its modern well equipped warehouse and cleaning plant at Brooks. All of the irrigated land in the province seems well adapted to alfalfa production and since there are over 1,100,000 acres of irrigable land in the irrigation projects already under way the seed production of this crop can be developed to a very much greater extent.

These irrigated areas centre around Strathmore, Brooks and Lethbridge at each of which places the work is directed by the Canadian Pacific Railway. North of Lethbridge is also the Lethbridge Northern Irrigation District while the Canada Land Irrigation Co. is located at Vauxhall, and smaller projects are situated at Taber and Glenwoodville. The amount of seed produced in 1931 by the association was 228,000 lbs. This is a somewhat smaller yield of seed than is usual.

Alsike clover has also proved to be highly satisfactory under irrigated conditions and has been grown for a number of years around Brooks. However, the area that seems to be most naturally adapted to this crop lies west and south of the City of Edmonton. Here soil and climate seem to suit alsike especially and the crop is gaining rapidly in popularity. This season is the first when any appreciable quantity of seed has been grown in this latter district.

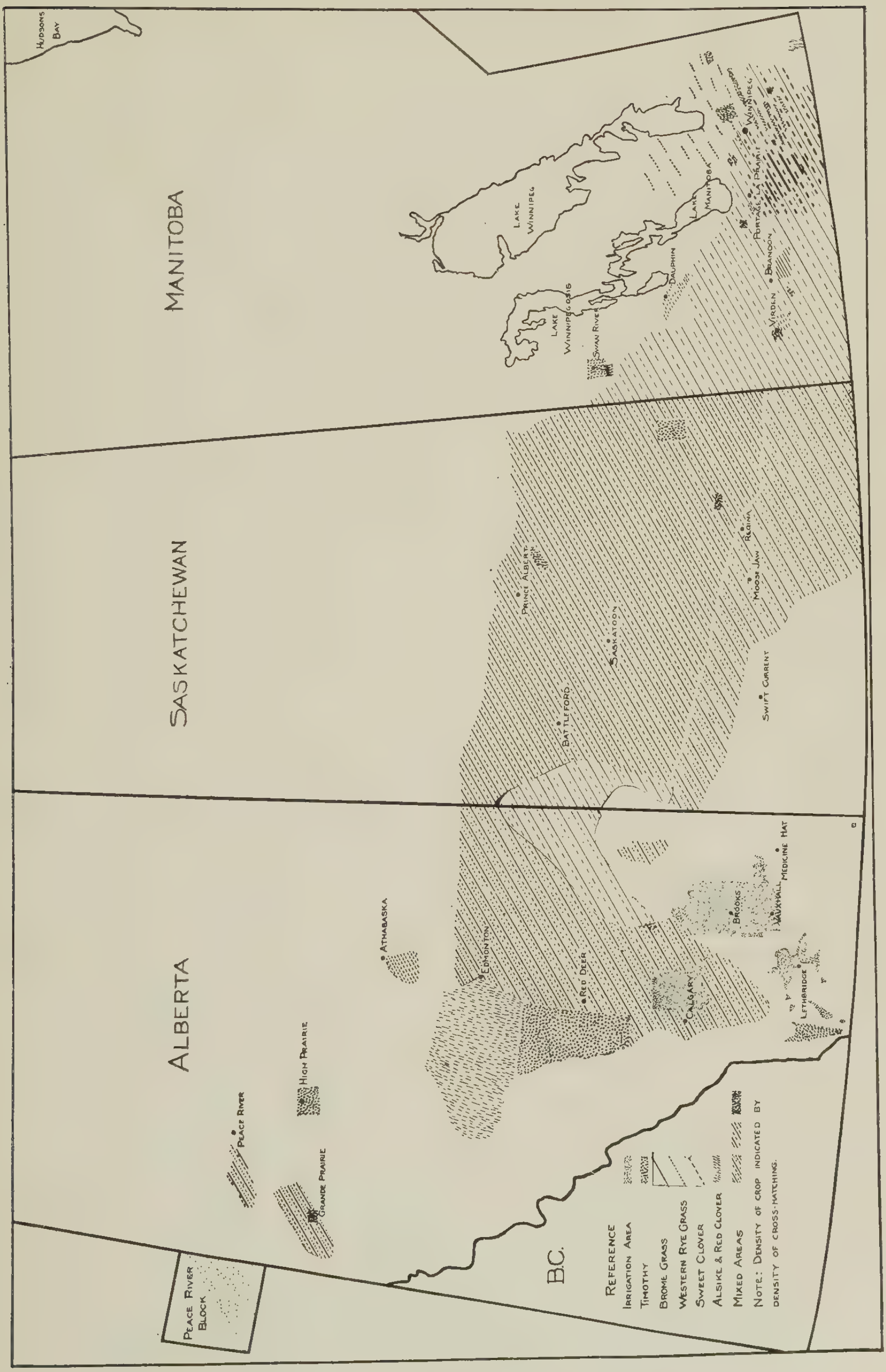
The red clover area in the province also coincides quite closely with the alsike district. No great amount of red clover seed has been produced to date but the quality of the small quantity that has been marketed is excellent and there is apparently no reason why the province cannot be self-supporting at least in this regard.

Timothy, during the season that has just passed (1931-32), produced the lowest yield of seed that the province has known for many years. Three areas in the province seem especially suited to this crop. They are the districts around Pincher Creek, in the south-west, the area of parkland along and west of the Canadian Pacific Railway between Calgary and Edmonton and the High Prairie and Grande Prairie districts in the north.

At Pincher Creek timothy production is handled by a co-operative association, the same handling both hay and seed. In the crop season of 1931 the sale of seed amounted only to about 125,000 pounds, but as stated this was a very light yield due to exceptionally dry conditions in this district. In the previous year the production in this district was well over 650,000 pounds and in earlier years production has greatly exceeded this amount. This district is well adapted to timothy production and the association is very well equipped with warehouse and cleaning equipment to handle large amounts of seed.

Brome grass has always been a popular crop in the province though seed production has never been very popular. Last season's crop was lighter than the previous one due to unusually dry conditions. An appreciable amount of the seed produced was field inspected and marketed as certified free-from-couch-grass seed.

Brome is the most important grass crop in Saskatchewan. The adaptability of this grass has made it most favoured for distribution, even though sufficient high grade seed to meet the demand is not produced in the province. It must be pointed out that a large number of farmers are afraid to purchase



Distribution of forage crop seed-producing areas in Western Canada.

brome, because of the chance of getting couch grass with it. As our work of certifying couch-free brome grass continues, it will remove at least some of the fear by providing protection to the purchaser. This crop can be grown in almost any area in Saskatchewan.

In the case of western rye grass, seed requirements are much lower than for brome grass. It is favoured for hay and seed production in the semi-arid districts, but it is not used to any extent as permanent pasture.

Sweet clover is very popular in this province and no area can be named specifically as a production centre, because it is grown all over the province. Until last year there was a scarcity of this seed on the market, but at the present time there is a surplus. Whether there would be a surplus if farmers had more money is doubtful and it is expected that there will be a good demand for it next year.

Alfalfa may be successfully grown over the major portion of Saskatchewan and usually remains productive over a period of years. The Grimm Alfalfa strain is most popular. There are two districts, producing seed, viz., the extreme south-west area and the north-east part of the province. Alfalfa is rapidly becoming more popular in all northern areas. It is impossible for us to estimate seed production. Approximately 7,655 pounds are produced from fields which met our inspection standards.

Timothy is not recommended by provincial agronomists, although it is grown quite successfully in a few districts. These are the Birch Hills district, a district east of Yorkton, running south to the international boundary and an area along the Qu'Appelle Valley, which should be fairly suitable for timothy seed production.

Government Distribution of Grass and Legume Seeds

Realizing the desirability of stimulating forage crop seed production in the prairie provinces authorization was given in the fall of 1931 to a plan for the distribution of grass and legume seeds by the Dominion Department of Agriculture.[3] This plan was carried out during the winter and spring by the Seed Branch of the Department working in conjunction with the provincial departments of agriculture and the provincial universities. The seed was distributed to carefully selected growers throughout the three provinces and an attempt was made to place as much of each kind as possible in areas where experience had shown it to be well suited. The following list indicates the total amounts of the different kinds distributed and the numbers of growers receiving seed of each kind.

Kinds	*Pounds*	*Numbers of growers*
Regular distribution:		
Alfalfa	56,582	817
Sweet clover	201,400	962
Brome grass	125,000	626
Western rye grass	35,400	166
Timothy	11,200	119
Altaswede red clover	2,500	42
Alsike clover	1,670	51
Crested wheat grass	466	333

[3] This plan was continued and extended in 1933.

Special distribution:		
Meadow fescue	500	4
Kentucky blue grass	620	6
Creeping red fescue	347	12

The alfalfa distributed in Alberta went largely to dry land areas, very little being distributed to the irrigated districts since it was felt that this crop was already well established under irrigation. Sweet clover and brome grass also were quite widely distributed throughout Alberta since these crops were known to have done well in all parts except those that are too dry for successful culture of the ordinary grasses. The same holds true in part for the western rye grass though perhaps the majority of this went into the northern part of the province particularly into the Peace River district. The High Prairie district received the majority of the timothy seed though a part of this was placed west of Red Deer in a representative part of the parkland area of the province. Alsike and red clover were placed principally in the west central part of the province, care being taken to be sure that the soil type and the climatic conditions were acceptable to these crops.

The committee in charge of this work in the province of Saskatchewan did not centralize the distribution, but made it general in order to safeguard the returns. There can be no doubt that a large percentage of those who received seed under this plan in both of the provinces would have been unable to secure seed, because of economic conditions, in any other way. Therefore it seems safe to assume that a large proportion of the men who received seed under this plan are new growers.

Distribution of forage crop seed in Manitoba was conducted on the same plan as in the other western provinces. Sweet clover, alfalfa, brome and western rye grass seeds were in greatest demand and were given general distribution. Timothy proved next in popularity but was allotted to definite districts,viz., Red River Valley, Eastern Manitoba, Inter-Lake, and Swan River. Red clover and alsike were allowed in the same districts as timothy but to comparatively few applicants. Meadow fescue was included in two central districts, chiefly for seed. Kentucky blue grass as an experimental seed project was placed with a few farmers near Winnipeg.

Possibility of Forage Crop Improvement

The fundamental needs for improvement of the grasslands of Canada are two fold. The first of these is an increase in acreage. The second is one to which the attention of investigators has been turning, that is the improvement of strains and varieties by selection and breeding.

In the past the attention of the majority of scientific workers for crop improvement has been focussed on the cereals. This was quite natural because of their importance as human food. With changing conditions attention is being directed to the forage crops, and these are likely to offer as great a field for improvement as did the cereals.

A great need lies in the introduction and testing of varieties; much fruitful work could be done by pursuing a policy of systematic exploration throughout the world for strains and varieties suitable for our soil and climatic conditions. Russia could possibly yield drought resistant strains of value under our conditions. It is within the range of possibility that such another

grass as Brome, which it will be recalled was introduced from a Hungarian origin in the 80's and developed by the late Dr. Angus McKay at Indian Head and has become the foremost grass for drier conditions, might be discovered. In passing, we should note that one of the promising grasses for dry land conditions, crested wheat grass, came within comparatively recent years from the steppe region of European Russian and southwest Siberia.

Within the grasses that we already have there is great room for improvement by the selection and segregation of strains that are of superior merit. Some excellent work has been done already within the Dominion and keen interest is being shown throughout the entire Empire on strain improvement. The establishment of the Welsh Plant Breeding Station at Aberystwyth, Wales, has done much to stimulate such interest as has the Plant Research Station at Palmerston North, New Zealand. Improvement of grasslands and improvement of methods for their management have become vital problems from an Imperial standpoint.

Note the following statement by E. Bruce Levy (*3*), Agrostologist of the New Zealand Research Station. "The significance of strain in pasture plants is rapidly becoming recognized throughout the world and it is not over much to prophesy that within a few years the grass seed trade of the world will be based on pedigree and type. The more widely and variously used the species the greater the significance attachable to strain within those species."

Dr. McConkey, of the Ontario Agricultural College in his bulletin, *Recent Advances in Pasture Management*, which deals with the development of grassland management as studied by him in Great Britain, brings added proof of the significance of the selection of strains within variety and draws attention to the necessity for the use of seeds of known type and ancestry. Quoting an experiment conducted at Aberystwyth, he compares certain selected indigenous strains of several English grasses with ordinary commercial seeds by counting the number of tillers sent up by each plant, with this startling result.

Kind	*Number tillers*
Cocksfoot (pedigree)	52.4
Cocksfoot (commercial)	11.8
Perennial rye (selected)	61.6
Perennial rye (commercial)	17.6
Tall Fescue (selected)	101.2
Tall fescue (commercial)	45.6

It is true that none of the grasses used in this experiment is of special interest to us on the prairies but nevertheless the test indicates very clearly that there are vast differences in the abilities of some strains to produce over others. It is in the selection and segregation of these strains that much work may be done for the betterment of grass production.

The time has arrived when the farmer on the prairies must learn to think of his grass and pasture land as 'crops' rather than merely as adjuncts that can be used to save cultivation of rough land or of fields that are too weedy for cereals. And in order to establish this concept of grass it is necessary that the farmer be shown that grasses are high in yield of valuable seed or

fodder. Much work also may be done in determination of the palatability and nutritive value of grasses so that types may be developed that will serve their purposes to the best advantage. Little work of this type has been as yet reported in Canada, although a great deal of this has been done in England and New Zealand. Such knowledge is of special value in the compounding of pasture mixtures.

Field Inspection and Seed Certification

The system of field inspection and seed certification operative under the Dominion Seed Branch is being applied rather extensively in the prairie provinces. The effect of certifying grasses and clovers can readily be seen in the greater popularity and demand for certified seeds when marketed. Under this system it is possible to certify grasses or legumes for any one characteristic or for a number of characteristics. The most common is probably certification for freedom from some particularly objectionable weed. Thus field inspection prior to harvesting makes possible certification of brome grass as free from couch grass, alsike clover as free from bladder campion, white blossom sweet clover as free from yellow blossom sweet clover or vice versa.

The marked popularity of brome grass seed certified as free from couch grass was noted this year by all seedsmen. Many farmers in the past have hesitated to purchase brome grass or western rye grass seed through fear of infesting their lands with couch grass. It seems to be a safe statement that no couch-free brome grass seed is being carried over by any seedsman this season.

Another use of certification applies to purity or isolation of strains of known quality and ancestry. A number of improved strains of grasses and legumes have been developed by our plant breeders. Much time and money has been expended in the development of these improved strains and the system of certification aids greatly in preserving the identity and quality of these superior stocks.

Conclusion

In this paper has been assembled the available information relating to Canadian imports and exports of forage crop seeds; seed production in the prairie provinces indicating the areas and extent of present production has been discussed, and the opinion is expressed that forage crop seed production may be considerably increased in suitable districts so that forage crops in general may comprise a more appropriate proportion of our cultivated acreage without the necessity of extensive importation of seed.

The author desires to express his thanks to Dr. J. R. Fryer, Associate Professor of Genetics and Plant Breeding at the University of Alberta, Edmonton, for helpful suggestions and criticism of this paper, and to acknowledge his indebtedness to the Provincial Departments of Agriculture, Alberta and Saskatchewan, to the various western officials of the Dominion Seed Branch for statistics received, and to other authorities whose findings have been used.

REFERENCES

1. O. McConkey. Recent advances in pasture management. Empire Marketing Board. July, 1931.
2. As compiled by Dominion Seed Branch Marketing Service, Ottawa.
3. E. Bruce Levy, Plant Research Station, Dept. of Agriculture, Palmerston, North, New Zealand.

THE EFFECT OF HARVESTING AT DIFFERENT STAGES OF MATURITY UPON THE YIELD AND CHEMICAL COMPOSITION OF BARLEY[1]

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Introduction

Barley is fast becoming a cereal crop of major importance in Manitoba. During the five year period 1925-1930, agricultural statistics (7) reveal that the annual barley acreage in Manitoba has represented 81% of the average annual wheat acreage for the same period. The average figure for the provinces of Saskatchewan and Alberta for the same period is 9%. When these two figures are compared, the importance of barley as a cereal crop in Manitoba can be readily appreciated.

An attempt will be made in this investigation to determine the effect of harvesting at different stages of maturity upon the yield of barley and also the nature and extent of variations in the mineral, carbohydrate and nitrogenous constituents of the component plant parts sampled daily from heading until past maturity.

Literature Review

Studies on the stage of development of cereal plants in relation to variations in yield and chemical composition have been reported upon from time to time on this continent and abroad. Most of these investigations have dealt with wheat, since it occupies throughout the world a position of prime economic importance. One of the earliest trials in Canada was that conducted by Bedford (*4*), who reported the results of two years' observations indicating that there was no increase in yield for wheat harvested at maturity, over that harvested a week early in the dough stage. Kiesselbach (*11*) found little change in the protein percentage of wheat from early dough to maturity, but a decided increase in yield and weight per bushel from early to late dough and slight increases after. Arny and Sun (*2*) reported on results obtained in the summer of 1925 from a series of wheat and oat plots. These investigators found that the weight per thousand kernels for both wheat and oats, for any date of sampling are as high for the grain dried rapidly in an oven with only the chaff or the chaff and rachis attached, as when curing proceeded more slowly with the same or more of the vegetative portions attached, indicating that translocation of food materials in leaves and stems after harvest did not occur in amounts large enough to be detected by the methods employed.

Brenchley (*5*) was the first investigator to study extensively the progressive development of the grain of barley. She reported her results on the basis of a unit of 1000 grains and presented them graphically by the use of curves. She found the per cent ash in the straw increased almost to maturity, while in the grain a definite decrease was observed. A definite relationship

[1] Part of a thesis submitted to the University of Manitoba in partial fulfillment of the requirements for the Degree of Master of Science.
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was found to exist between the maximum ash content and the maximum protein content in both the whole plant and grain. Comparing wheat and barley the above author noted that in barley the per cent dry matter and ash is considerably higher than in wheat. Brenchley and Hall (*6*) were the first investigators to report upon the distribution of the carbohydrate content of a cereal crop. In their investigations on wheat and barley they considered the carbohydrate as that part of the dry matter less protein and ash, which must be admitted does not represent the true carbohydrate content.

Thatcher (*13*) some years later in an investigation of wheat reported a regular decrease in per cent ash, ether extract, sugars (as Dextrose) and crude fibre up to maturity, with a marked increase in per cent protein in the later stages of development. Thatcher found that at all subsequent stages of development after the first three days, rapid and slow accumulation of dry matter appear to alternate. Harlan and Pope (*10*) reported on variations in the moisture content of the kernels of barley during growth and maturation. They found the moisture content of the kernels declined steadily from 80% at flowering to about 42%, and at this time the deposition of dry matter is interrupted and the kernels dry with great rapidity.

More recently Woodman and Engledow (*15*) have reported results on wheat which led them to conclude that the storage of carbohydrate was complete at the stage corresponding with the beginning of dessication. Starch was shown by chemical tests to be present in every one of the samples. The first samplings were found to be richest in reducing sugars as indicated by the reducing power of aqueous extracts; subsequent samples gave a definite fall in reducing sugars during the dessication period. Wilson and Raleigh (*14*) in 1929, in a continuation of the work of Arny and Sun found a decrease in the per cent nitrogen of the grain, glumes and rachis with approaching maturity. While the per cent in the leaves remained constant during ripening, an increase was noted in the internodes. Recently Fagan and Watkin (*8*) working in Wales on four different oat varieties have reported on an extensive investigation into the chemical constituents of the oat plant. They found that the relative proportion of the constituents was indicated by a progressive fall in the leaf, irregular fluctuations in the stem, and regular increases in the spikelet with approaching maturity.

While there is considerable variance in the results of the work reviewed, the indications are that, when the grain is harvested earlier than the stage when the majority of the kernels are in the hard dough, a reduction in both yield and weight per measured bushel is likely to occur.

Previous investigations also indicate that there is a decrease in per cent ash, moisture and protein, and an increase in per cent dry matter with approaching maturity. What little evidence has been presented regarding the carbohydrate distribution is contradictory.

Methods

The investigations hereafter reported were conducted in both 1930 and 1931 with the O.A.C. 21 variety. This variety was selected because it is generally recognized in Canada as the standard both from a malting and feeding standpoint.

In the spring of 1930 several one-hundredth acre plots were sown, average seasonal conditions prevailed and cuttings were secured from four different plots beginning July 21st and continuing at three-day intervals, with one or two exceptions until the crop was considered mature. Four plots were also harvested four days after the crop was mature, to determine if there was any significant reduction in yield due to shattering. The harvested grain from these plots was shocked and capped with cotton sheets to prevent weathering. The plots were threshed individually in an experimental thresher and yield results secured.

Determinations were made on the threshed grain of 1000 kernel weight, and weight per measured bushel. The 1000 kernel weights were determined from quadruplicate counts of 500 kernels and these averaged to give the result for each of the 36 plots. The results have been analyzed by taking the differences between paired values directly, and the significance of the variations from cut to cut determined. The weight per measured bushel was determined on the composite sample of threshed grain for any one cutting.

In the spring of 1931, O.A.C. 21 barley was sown in drills one foot apart on May 28th, on well prepared summerfallow. The soil is a dark, heavy lacustrine clay, high in mineral and organic matter. The weather records during the growing period are given in Table 1 and indicate that for the first two months (May and June) the mean temperatures were somewhat higher than normal, and that less than half of the normal precipitation occurred. The seedlings emerged on June 5th, and sampling was begun on July 13th, when the crop was completely headed and pollination had been complete for a number of days, as indicated by the shedding of the stamens. The samples were extracted from the bulk grain as it stood in the field, thus representing farm conditions. This method of sampling has been used by previous investigators and found to be quite satisfactory (*2*). Each day's sampling was purely random and no attempt was made to cut plants of uniform maturity. The samples were cut daily at mid-day, covered with a cotton sheet, taken to the laboratory and separated into their component parts, namely, leaves, culms and heads, as quickly as possible to minimize the loss of moisture. A definite weight of these along with whole plant samples were placed in cages and dried in an experimental drier which is a duplicate of the one described by McRostie (*12*). The samples were left in the drier for a period of from 2 to 3 hours, and at this time the moisture content ranged from 3 to 5%. The dried samples were then removed, ground in a Wiley mill until they would pass through a one millimetre sieve and placed in air tight containers until such time as the chemical determinations could be made.

TABLE 1.—*Meteorological conditions during the growing season (1931).*

	Temperature degrees Fahrenheit				Precipitation		Hours of sunshine			
Month	Maximum	Minimum	Mean	Normal	in Inches	Normal	Hours	Possible	% of Possible	Normal
April	77	10	40.3	37.9	.16	1.48	231.0	414.0	56	204
May	90	18	50.2	51.7	1.27	2.25	244.5	478.5	51	255
June	97	31	65.3	62.0	1.27	3.18	281.5	489.2	57	257
July	97	44	67.6	66.2	3.26	3.13	319.0	492.0	58	257
August	99	32	66.0	63.4	2.83	2.34	259.5	447.0	58	257

The chemical determinations such as moisture, ash, protein and total carbohydrate were carried out according to the Official Methods outlined in (*1*) and (*3*). In the carbohydrate results reported here, the reducing sugars were determined by the Quizumbing and Thomas (*3*) method as outlined. The sucrose was determined by inverting an aliquot of the sugar solution with hydrochloric acid as outlined in (*3*) under plant and plant products. The starch was determined by direct acid hydrolysis, and this method includes as starch the pentosans and other carbohydrate bodies that undergo hydrolysis and are converted to reducing sugars on boiling with hydrochloric acid. Carbohydrate determinations were conducted in duplicate on every second sample from heading to past maturity. All the samples were treated with anhydrous alcohol free ether to remove the fats before any attempt was made to extract the sugars. The reducing sugar and sucrose results have been reported as invert sugar, and the starch results as dextrose.

In the determination of total carbohydrates a battery of four Gooch crucible holders was assembled and suction was created by the use of a Cenco Hyvac pump. This arrangement was very efficient and helped materially to speed up the process of determining sugars, since two samples in duplicate can be filtered at one time. The results of the chemical determinations have been reported in per cent and on a uniform moisture basis.

In 1931 samples were again taken to obtain information on yield data. Cuttings were made of four rod rows beginning August 1st and continuing at two day intervals with one exception until 4 days after maturity. The weight per 1000 kernel determinations were also made on the threshed grain from each rod row.

Since it is much easier to associate changes in yield and composition with some easily observed morphological condition, general agronomic notes were taken from time to time as indicated by the following records: July 11—10% emergence of heads; July 13—heading complete, shedding stamens; July 24—kernels in the milk stage; July 26—kernels in soft dough, lower leaves beginning to fade in color, first appearance of rust; August 4—awns turning yellow, straw beginning to rattle and crack when bent, leaves 45% dry, kernels in firm dough; August 11—culms mostly yellow at first internode, leaves completely desiccated, kernels in hard dough; August 13—the crop was dead ripe and shedding of awns was observed to be general on 13th and 14th.

I. Field Plot Results in 1930

The significance of the plot yields was determined by the direct pairing method. This consists of finding the difference between the two items compared, and their mean difference. From this Mean, the Standard Deviation of the several differences is found by the usual formula. The ratio of the Mean difference to its Standard Deviation is designated as "t", the distribution of which has been calculated by Fisher (*9*). Fisher's Tables were used here in order to determine the significance of "t".

The yield per plot and the statistical significance of the experimental data are presented in Table 2. In determining the significance of the difference between barley cut 19 days early and that cut at maturity, a "t" value of 22.4 was obtained. Since a "t" value of 5.84 gives 100:1 odds, the difference observed is highly significant. Similar significant differences were obtained

for the cuttings made on July 24th (16 days early) and July 28th (12 days early.) The differences in yield when the cuttings were made 9, 5 and 3 days early and 5 days late were not significant.

TABLE 2.—*Yield in bushels per acre of individual one-hundredth acre plots of O.A.C. 21 barley harvested at different stages of maturity at Winnipeg in 1930, and the statistical estimation of the difference.*

Plot No.	Date harvested							
	July 21	July 24	July 28	July 31	Aug 4	Aug. 6	Aug. 9	Aug. 14
1	8.3	16.7	16.1	33.3	28.1	36.4	30.7	29.2
2	8.8	12.5	19.8	19.8	21.4	31.2	32.3	28.1
3	6.2	15.6	18.2	17.7	28.6	39.6	31.2	31.2
4	7.3	13.5	21.4	30.2	39.1	39.1	31.8	29.2
Mean yield	7.6	14.6	18.9	25.2	29.3	36.6	31.5	29.4

Cuttings compared	*Mean differences*	"*t*"
July 21 – August 9	23.8	22.4
July 24 – August 9	16.9	12.0
July 28 – August 9	12.6	12.8
July 31 – August 9	6.2	1.6
Aug. 4 – August 9	2.2	.60
Aug. 6 – August 9	5.1	2.43
Aug. 14 – August 9	2.1	2.41

5% Point = 3.18

TABLE 3.—*Average weight per 1000 kernels in grams, of individual plots of O.A.C. 21 barley harvested at different stages of maturity, and the statistical estimation of the differences.*

Plot No.	Date harvested							
	July 21	July 24	July 28	July 31	Aug. 4	Aug. 6	Aug. 9	Aug. 14
1	13.62	17.76	22.21	25.86	27.94	27.59	32.06	25.94
2	15.22	17.02	22.52	25.71	25.54	29.16	31.00	25.19
3	12.31	18.10	21.97	26.07	27.96	28.24	26.82	25.97
4	13.78	18.87	22.68	26.74	29.84	26.48	29.16	28.17
Mean weight	13.73	17.94	22.34	26.09	27.82	27.87	29.76	26.32

Cuttings compared	*Mean difference*	"*t*"
July 21 – August 9	16.03	19.30
July 24 – August 9	11.82	8.50
July 28 – August 9	7.42	6.81
July 31 – August 9	3.66	2.88
Aug. 4 – August 9	1.94	1.16
Aug. 6 – August 9	1.89	1.52
Aug. 14 – August 9	3.44	2.36

5% Point = 3.18

Along with the significantly lower yield of early cut barley it might be expected that differences in weight of kernels would exist. This expectation is confirmed in the data summarized in Table 3. Significant differences were obtained in weight per 1000 kernels for the barley harvested, 19, 16 and 12 days early. As in the case of the yield data, barley harvested 9, 5 and 3 days

early and 5 days late gave no significant differences in 1000 kernel weight, when compared with barley harvested at full maturity.

The weight per measured bushel on the composite samples for each cutting (Table 5) was found to increase regularly up to 9 days before ripe; from this time on there was little change.

II. Field Results 1931

In 1931 four rod rows were cut at two day intervals, beginning August 1st (12 days early), until the crop was mature and then 1 and 4 days after ripe. The samples were allowed to stand in the field until ready for threshing. The yield in bushels per acre was computed and the results analyzed as in 1930 to determine the significance of the differences between the various cuts as compared with the mature crop. These results are presented in Table 4. A significant difference in yield was obtained for the barley cut 12, 10 and 8 days early as compared with that harvested normally. The cuttings made 6, 4 and 2 days early, and 1 day late gave no significant differences. The rod rows harvested 4 days late gave a significant decrease. This decrease is no doubt due to shattering and losses from mechanical causes during harvest operations.

The weight per thousand kernels was determined on a number of samples taken daily from July 27th to August 17th and which had been dried immediately in the drier. The same uniform increase up to near maturity, with a slight decrease after as occurred in the 1930 results can be observed. A summary of the two years' yield results is given in Table 5. The results indicate that no significant decrease in yield or 1000 kernel weight will result from cutting barley one week before mature. Decreases in yield can be expected to result from late harvesting, due to shattering and mechanical loss of heads.

Table 4.—*Yield in bushels per acre of individual rod rows of O.A.C. 21 barley harvested at different stages of maturity at Winnipeg in 1931, and the statistical estimation of the differences.*

Plot No.	Date harvested								
	Aug. 1	Aug. 3	Aug. 5	Aug. 7	Aug. 9	Aug. 11	Aug. 13	Aug. 14	Aug. 17
1	27.8	33.9	23.0	43.0	47.2	55.2	54.4	50.8	37.5
2	34.5	42.4	47.2	63.5	63.3	63.5	66.6	53.8	53.8
3	32.7	37.5	38.7	61.1	48.4	53.8	63.5	62.3	49.0
4	14.5	31.5	17.5	36.9	42.4	48.4	35.1	47.2	29.6
Mean yield	27.4	36.3	31.6	51.1	50.1	55.2	54.9	53.5	42.5

Cuttings compared	*Mean differences*	"*t*"
August 1 – August 13	27.5	10.26
August 3 – August 13	18.6	3.62
August 5 – August 13	23.3	7.52
August 7 – August 13	3.8	1.37
August 9 – August 13	4.6	1.00
August 11 – August 13	.32	.07
August 14 – August 13	1.4	.27
August 17 – August 13	12.4	4.96

5% Point = 3.18

TABLE 5.—*Summary of the yield and 1000 kernel weight results for the years 1930 and 1931.*

1930 1/100 Plot Results							1931 Rod Row Results				
Date cut	Days before ripe	Average yld. in bus. per acre	"t" value	Wt. per bushel	Average 1000 Kernel weight grams	"T" values	Date cut	Days before ripe	Average yld. per acre in bushels	"t" value	Average 1000 kernel weight grams
July 21	19	7.6	22.4	30.	13.73	19.30	Aug. 1	12	27.4	10.26	21.96
24	16	14.6	12.0	36.5	17.94	8.50	3	10	36.3	3.62	23.56
28	12	18.9	12.8	42.5	22.34	6.81	5	8	31.6	7.52	25.46
31	9	25.2	1.6	47.5	26.09	2.88	7	6	51.1	1.37	27.88
Aug. 4	5	29.3	.60	47.5	27.82	1.16	9	4	50.1	1.00	29.42
6	3	36.6	2.43	48.0	27.87	1.52	11	2	55.2	.07	30.57
9	—	31.5	—	49.0	29.76	—	13	—	54.9	—	29.74
	After							After			
14	5	29.4	2.41	48.5	26.32	2.36	14	1	53.5	.27	30.39
							17	4	42.5	4.96	28.50

III. Results of Chemical Determinations

After having observed the variations that occur in yield and quality with respect to harvesting at different stages, further observations lead naturally to a consideration of the internal changes that may have occurred in the barley grown under the same conditions. It is an established fact that early in their development plants rapidly take up mineral nutrients from the soil. These materials are elaborated, stored in the stems and leaves, and later transferred to the heads and kernels. Accordingly a larger amount of stored material should be found in the leaves and stems before the kernel is well formed. Results will be presented which will substantiate this fact. Weather conditions during the period of sampling no doubt have an effect upon the daily variation in chemical composition, although no significant correlations were obtained in this study. Meteorological records are also of interest when comparisons have to be made between the conditions under which this experiment was conducted and conditions elsewhere. The daily variations in the meteorological conditions during the period of sampling are available, but have been omitted due to lack of space.

The Dry Matter and Moisture Results

The daily fluctuations in per cent dry matter in the different plant parts and whole plant samples, and the variations in per cent moisture are given in Table 6. The percentage dry matter in heads and whole plant samples increases regularly from heading to maturity. The per cent dry matter in the leaves fluctuates greatly but in general increases up to fourteen days after heading, following by a stationary period of one week, and then a rapid increase up to maturity. During this period from 14 days after heading until 20 days after, the kernels were in the soft milk to firm dough. This would indicate that during the period of rapid starch infiltration plant materials are translocated from the leaves almost as fast as they are manufactured. In the culms on the other hand, the per cent dry matter increased up to 14 days, followed by a fall for a period coincident with that of the leaves, and then a slight gradual increase to maturity. The per cent dry matter in the heads is higher at all stages than that of the leaves and culms, the relative percentages for the last sampling for the leaves, culms and heads being 85, 40 and 96 respectively.

TABLE 6.—*Daily variations in per cent dry matter and per cent moisture in O.A.C. 21 barley.*

Date Sampled	Days from Heading	% Dry Matter				% Moisture (Green Weight)				Daily Decrease or Increase in % Moisture			
		Leaf	Culm	Head	Plant	Leaf	Culm	Head	Plant	Leaf	Culm	Head	Plant
July 13	1	18.0	14.8	20.7	18.4	82.0	85.2	79.3	81.6	.....	.....	.....	.....
14	2	19.2	15.7	24.4	19.0	80.8	84.3	75.6	81.0	—1.2	— .9	—3.7	— .6
15	3	18.2	14.6	20.7	17.6	81.8	85.4	79.3	82.4	+1.0	+1.1	+3.7	—1.4
16	4	18.9	16.0	24.1	18.2	81.1	84.0	75.9	81.8	— .7	—1.4	—3.4	— .6
17	5	21.6	17.2	27.9	20.0	78.4	82.8	72.1	80.0	—2.7	—1.2	—3.8	—1.8
18	6	17.0	18.2	29.2	21.6	83.0	81.8	70.8	78.4	+4.6	—1.0	—1.3	—1.6
19	7	20.1	18.5	29.8	21.6	79.9	81.5	70.2	78.4	—3.1	— .3	— .6	0.0
20	8	24.2	22.2	35.1	26.2	75.8	77.8	64.9	73.8	—4.1	—3.7	—5.3	- 4.6
21	9	22.7	21.1	34.9	25.3	77.3	78.9	65.1	74.7	+1.5	+1.1	+ .2	+ .9
22	10	24.2	22.7	34.8	27.1	75.8	77.3	65.2	72.9	—1.5	—1.5	+ .1	—1.8
23	11	26.0	23.6	36.4	28.0	74.0	76.4	63.6	72.0	—1.8	— .9	—1.5	— .9
24	12	26.8	25.4	35.8	27.6	73.2	74.6	64.2	72.4	— .8	—1.8	+ .6	+ .4
25	13	26.0	29.7	38.5	29.0	74.0	70.3	61.5	71.0	+ .8	—4.3	—2.6	—1.4
26	14	32.6	30.8	41.1	33.9	67.4	69.2	58.9	66.1	—6.6	—1.1	—2.6	—4.9
27	15	29.5	28.9	40.1	29.4	70.5	71.1	59.9	70.6	+3.1	+1.9	+1.0	+4.5
28	16	31.9	27.2	41.0	30.7	68.1	72.8	59.0	69.3	—2.4	+1.7	— .09	—1.3
29	17	33.9	28.9	43.6	35.5	66.1	71.1	56.4	64.5	—2.0	—1.7	—2.6	—4.8
30	18	32.8	27.3	43.8	33.1	67.2	72.6	56.2	66.9	+1.0	+1.5	— .2	+2.4
31	19	31.5	27.3	46.4	33.2	68.5	72.7	53.6	66.8	+1.4	+ .1	—2.6	+ .1
August 1	20	24.9	26.5	41.6	31.8	75.1	73.5	58.4	68.2	+.6	+ .8	+1.4	+1.4
2	21	....	....	....	....	....	....	....	....	.....	.....	.....	.....
3	22	32.0	27.0	49.4	35.5	68.0	73.0	50.6	64.5	—7.2	— .5	—7.8	—3.7
4	23	38.2	30.1	51.8	36.8	61.8	69.9	48.2	63.2	—6.2	—3.1	—2.4	—1.3
5	24	39.9	30.2	54.0	38.9	60.1	69.8	46.0	61.1	—1.7	— .1	—2.2	—2.1
6	25	44.0	31.2	57.0	43.6	56.0	68.8	43.0	56.4	—4.1	—1.0	—3.0	—4.7
7	26	44.3	29.6	56.3	41.8	55.7	70.4	43.7	58.2	— .3	+1.6	+ .7	+1.8
8	27	26.9	25.1	51.1	35.1	73.5	74.9	48.9	64.9	+17.8	+4.5	+5.2	+6.7
9	28	49.9	30.8	60.6	42.7	50.1	69.2	39.4	57.3	—23.4	—5.7	—9.5	—7.6
10	29	61.0	31.4	60.7	47.0	39.0	68.6	39.3	53.0	—11.1	— .6	— .1	—4.3
11	30	67.5	33.1	67.0	49.7	32.5	66.9	33.0	50.3	—6.5	—1.7	—6.3	—2.7
12	31	85.2	33.4	71.5	51.6	14.8	66.6	28.5	48.4	—17.8	— .3	—4.5	—1.9
13	32	85.5	34.7	77.6	57.6	14.5	65.3	22.4	42.4	— .3	—1.3	—6.1	—6.1
14	33	....	37.0	88.4	59.3	....	63.0	11.6	40.7	.....	—2.3	—10.8	—1.7
15	34	....	39.0	91.4	59.3	....	61.0	8.6	40.7	.....	—2.0	—3.0	0.0
16	35	....	....	....	....	....	....	....	....	.....	.....	.....	.....
17	36	....	40.2	96.2	60.4	....	59.8	3.8	39.6	.....	—1.2	—4.8	—1.1

The moisture results indicate a uniform decline with approaching maturity for all the plant parts as well as the whole plant samples.

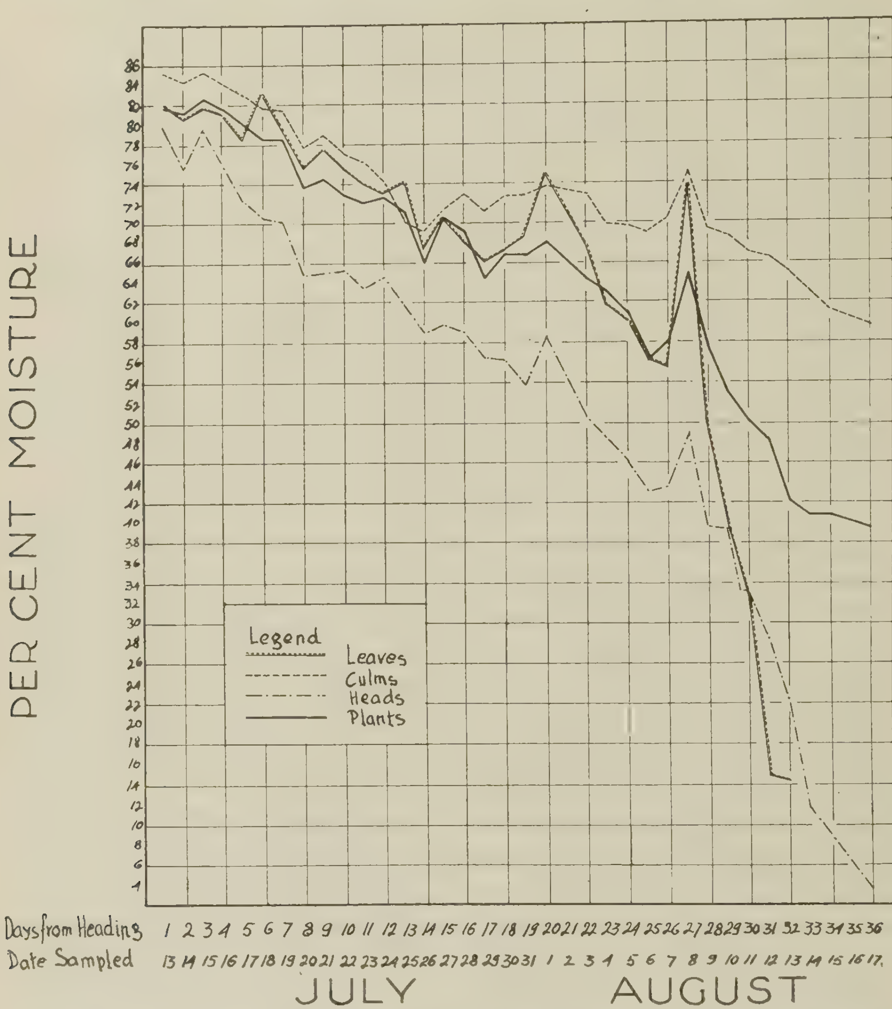

Figure 1. The daily trend in per cent moisture (green weight) in the plant parts and whole plant samples from heading to past maturity.

The per cent moisture on the basis of green weight is given in Table 6. These results are depicted graphically in Figure 1. The per cent moisture in the heads decreased regularly from 1 to 29 days after heading, but from this time on, a rapid fall occurs. The marked fluctuations in the per cent moisture in the leaves are to be expected since they are the active tissue, and respond quickly to fluctuations in meteorological conditions. In the culms the general trend is down for the first 15 days, followed by a more or less stationary period for 7 days, and finally a gradual decrease to maturity. It is interesting to note that no rapid fall occurs in the culms with approaching maturity, such as occurs in the other plant parts. This would seem to in-

dicate that some translocation of food material must be taking place almost to the end, or that the cells contain large amounts of physically bound water. The marked increases in per cent moisture on July 15th, August 1st, and August 8th are due to the fact that the samples contained considerable surface moisture, due to rain. The results in general indicate that all the plant parts except the culms, decrease regularly in per cent moisture up to the hard dough stage, and from then on, very rapidly due to desiccation. The culms however never reach a moisture content as low as the heads and leaves. The period of uniform moisture content in the culms coincides closely with the period of rapid storage of material in the kernel.

The daily increase or decrease in per cent moisture indicated in Table 6 shows periods of increase and decrease from day to day. This is quite in accord with the observation made by Thatcher (*13*) on wheat and oats. The average daily decrease for the leaves, culms, heads and whole plant samples was found to be: 2.2; 0.8; 2.3; and 1.4 per cent respectively, giving an average for all the determinations of 1.7 per cent. Investigations conducted on barley at Rothamsted (*5*) and Aberdeen (*10*) indicated a daily decrease in moisture of 1 per cent and 2 per cent respectively.

The Ash and Protein Results

The per cent ash was determined by the modified Alcohol Glycerol Method as outlined in (*1*). Great difficulty was experienced in ashing the head samples from the period July 23rd to 29th. This represents a period from the time the kernels were in the milk stage until about the firm dough stage. All modifications and combinations of temperatures, with and without the addition of alcohol and glycerol were used, but particles of carbon still persisted. The ashing problem at this particular stage would seem to bear further investigating.

The protein was determined by the Kjeldahl method outlined in (*3*), the per cent nitrogen being multiplied by the factor 6.25, since this is the factor used in reporting per cent crude protein in all barley malting tests.

The results reported to a 13.5% moisture basis are given in Table 7. The results for the plant parts and whole plant samples are outlined in Figures 2 and 3.

The ash content of the leaves shows a marked decrease to 5 days after heading, followed by a period of considerable fluctuation for 2 to 3 day periods and then a gradual rise to the high point 5 days before ripe, with a gradual falling to maturity. In general the trend is an increase to maturity. The per cent ash in the leaves is considerably higher than in either the culms or heads. The distribution of the ash in the culms is indicated by a regular decrease to 24 days after heading, when the kernels are in the firm dough, and then a marked increase to maturity.

In the head samples the per cent ash shows a tendency to increase up to 8 days after heading, then to remain more or less uniform for a period of 10 days, with finally a period of decrease to maturity. The whole plant samples indicate a slight decrease with approaching maturity.

The trend of the per cent protein is given in Figure 3. The protein content of the leaves decreases rapidly from heading to maturity; the same decrease to maturity takes place in the culms although not so great. The

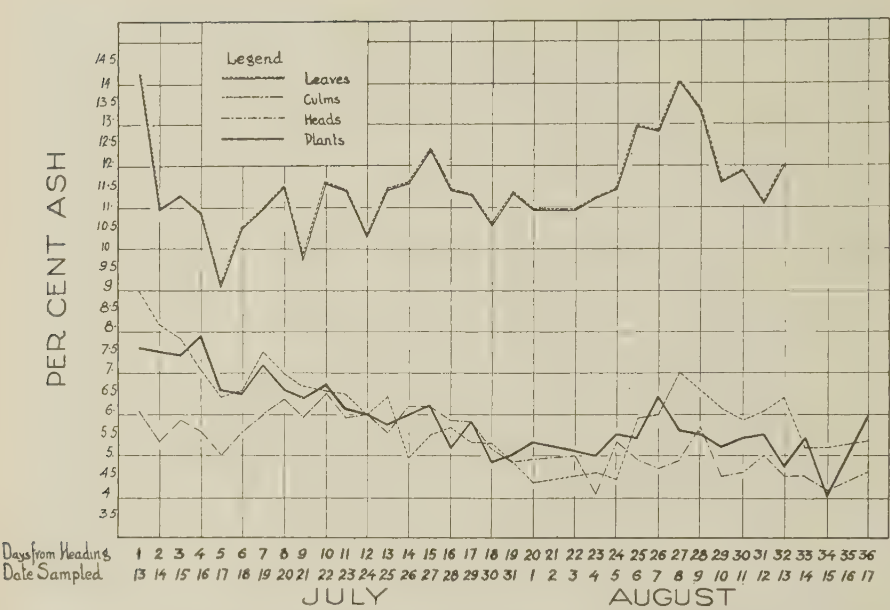

Figure 2. Changes in ash content (13.5% moisture basis) from day to day in the component parts and whole plant samples from heading to past maturity.

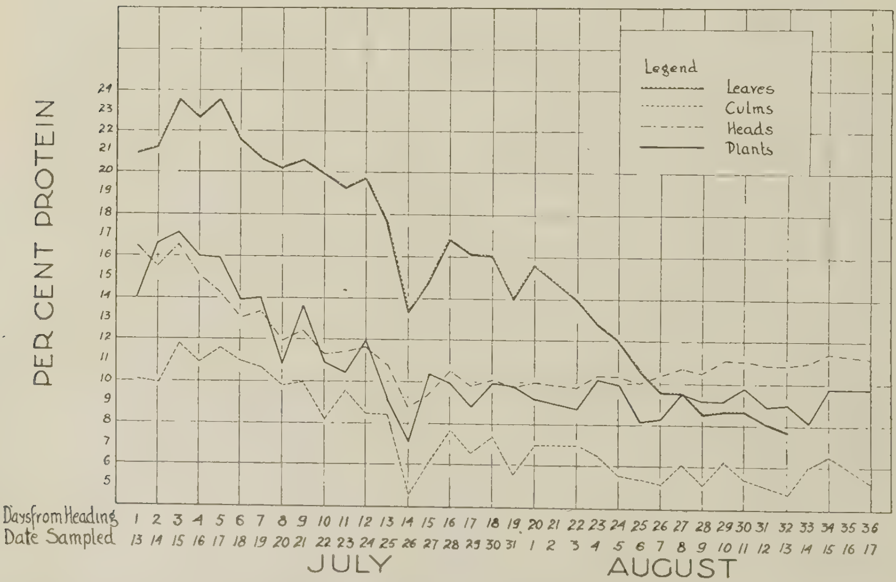

Figure 3. Variation in per cent protein (13.5% moisture basis) in the plant parts and whole plant samples from heading to past maturity.

head samples decreases regularly to fourteen days after heading, or until the kernels are in the soft dough stage. From this time on however, a slight regular increase is noted up to 4 days past maturity. The steady decline in the per cent protein in the leaves and culms during the grain forming period indicates that the rate of migration into the grain exceeds that of the intake into either the culms or leaves.

TABLE 7.—*The daily per cent ash and protein content of plant parts and whole plant samples from heading to 4 days past maturity (13.5% moisture basis).*

Date cut	Days from heading	Per cent ash				Per cent protein (N x 6.25)			
		Leaf	Culm	Head	Plant	Leaf	Culm	Head	Plant
July 13	1	14.25	9.05	6.11	7.55	20.9	10.1	16.5	14.0
14	2	10.94	8.21	5.32	7.45	21.2	9.9	15.5	16.6
15	3	11.25	7.77	5.76	7.35	23.5	11.8	16.6	17.1
16	4	10.85	7.08	5.57	7.85	22.6	10.9	15.1	16.0
17	5	9.13	6.41	4.96	6.62	23.5	11.6	14.3	15.9
18	6	10.49	6.62	5.57	6.46	21.5	11.0	13.0	13.9
19	7	10.94	7.53	6.03	7.19	20.6	10.7	13.3	14.0
20	8	11.49	7.04	6.33	6.63	20.2	9.8	11.9	10.8
21	9	9.72	6.72	5.89	6.36	20.5	9.9	12.4	13.6
22	10	11.61	6.64	6.47	6.73	19.9	8.2	11.3	10.9
23	11	11.36	6.46	5.89	6.18	19.3	9.6	11.4	10.4
24	12	10.26	5.99	6.03	5.96	19.7	8.5	11.6	11.9
25	13	11.42	6.42	5.64	5.69	17.6	8.5	10.8	9.2
26	14	11.57	4.92	6.19	5.98	13.3	4.6	8.8	7.1
27	15	12.27	5.48	6.17	6.20	14.7	6.1	9.4	10.3
28	16	11.37	5.71	5.78	5.21	16.7	7.7	10.6	9.9
29	17	11.30	5.30	5.75	5.85	16.1	6.6	9.8	8.8
30	18	10.58	5.34	5.20	4.78	16.0	7.4	10.1	9.9
31	19	11.31	4.85	4.83	5.05	13.9	5.5	9.8	9.8
Aug. 1	20	10.94	4.34	4.92	5.27	15.5	7.0	10.0	9.2
2	21	.....	....	....	....	....	....	....	....
3	22	10.88	4.48	4.96	5.14	13.9	7.0	9.8	8.7
4	23	11.21	4.60	4.10	4.98	12.7	6.5	10.3	10.1
5	24	11.36	4.36	5.29	5.52	12.0	5.6	10.3	9.9
6	25	12.89	5.94	4.90	5.39	10.5	5.4	10.0	8.2
7	26	12.81	6.01	4.67	6.44	9.5	5.2	10.4	8.3
8	27	14.02	7.00	4.89	5.58	9.5	6.1	10.7	9.5
9	28	13.33	6.63	5.68	5.49	8.5	5.2	10.5	9.2
10	29	11.58	6.18	4.53	5.23	8.6	6.2	11.1	9.2
11	30	11.83	5.84	4.64	5.45	8.6	5.4	11.1	9.8
12	31	11.08	6.13	4.97	5.47	8.1	5.1	10.9	8.9
13	32	11.99	6.43	4.51	4.67	7.7	4.7	10.9	9.0
14	33	.....	5.21	4.53	5.36	....	6.0	11.0	8.2
15	34	.....	5.25	4.16	3.99	....	6.5	11.4	9.7
16	35	.....	....	....	....	....	....	....	....
17	36	.....	5.29	4.63	5.92	....	5.3	11.2	9.7

CARBOHYDRATE RESULTS

The results of the reducing, sucrose and starch determinations on the leaves, culms and head samples are given in Table 8. It must be noted here that the starch results for the head samples are low and this is due to the fact that the head samples did not consist of the grain only, but the glumes, rachis and awns were included. The head samples would therefore have a much higher crude fibre content than the threshed grain only, resulting in a material reduction in per cent carbohydrate.

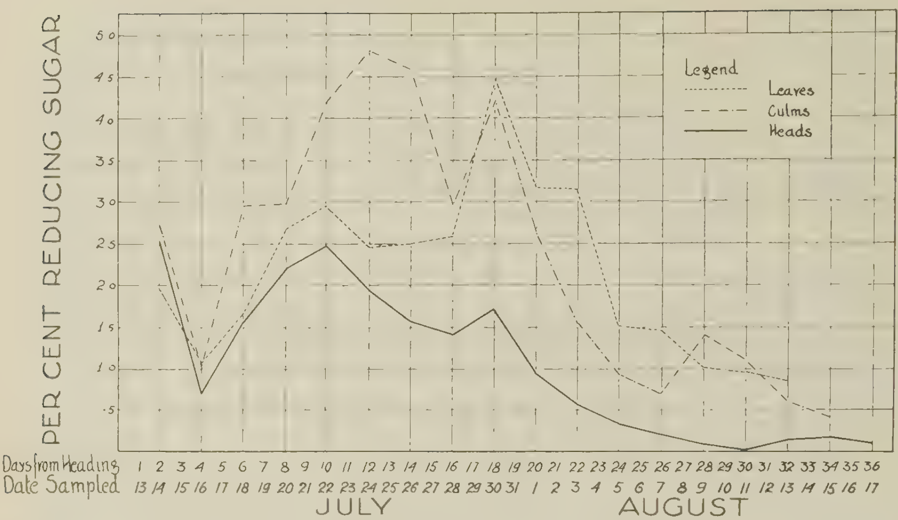

Figure 4. The trend in per cent reducing sugar (as invert) in leaves, culms, and heads of O.A.C. barley at two day intervals from heading to past maturity.

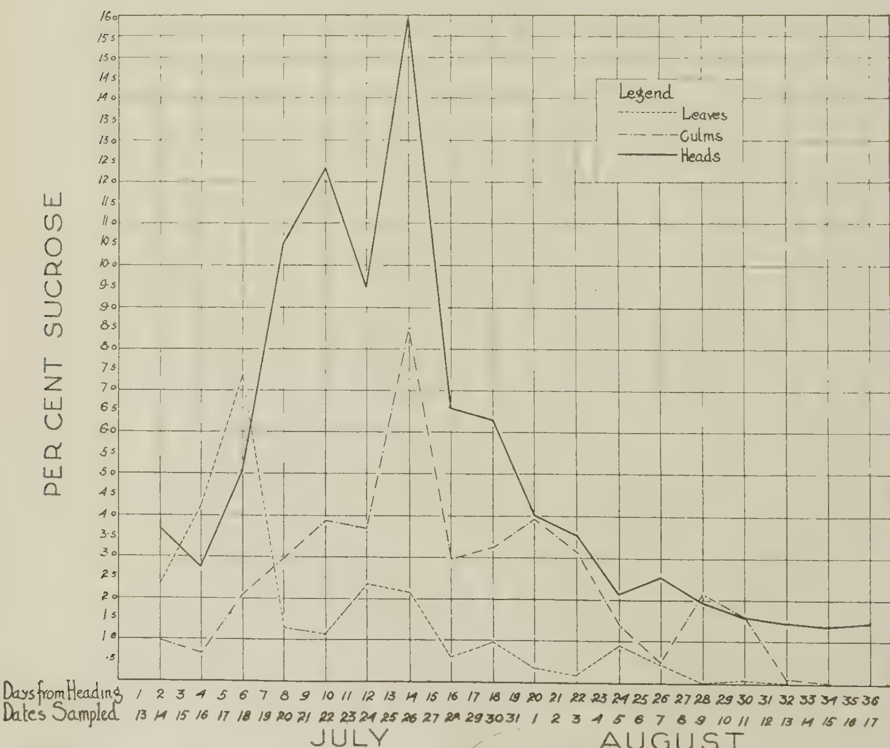

Figure 5. The distribution of the per cent sucrose (as invert) in the leaves, culms and heads at two day intervals.

The distribution of the per cent reducing sugar in the culms, leaves and heads is given in Figure 4. There is a marked decrease in reducing sugars in all the plant parts 4 days after heading. This may be due to a 3 day rain which took place at this time and a period of relatively little sunshine, which would indicate that photosynthetic processes in the plant were not active or not as active as translocation processes. The reducing sugars in the leaves increased from this time until 18 days after heading, when the kernels were almost in the firm dough stage. From this stage on the per cent reducing sugars in the leaves decreases rapidly. The maximum content of reducing sugars in the culms is found 12 days after heading. From this period, which coincides with the milk stage, a rapid decline is observed. In the head samples the increase and decrease in per cent reducing sugar practically coincides with that of the culms, although the actual percentage is less.

TABLE 8.—*The distribution of reducing sugars, sucrose and starch at two-day intervals from heading to past maturity in the component parts of O. A. C. 21 barley.*

Date sampled	Days from heading	Leaf			Culm			Head		
		Percent reducing sugars	Percent sucrose	Percent starch	Percent reducing sugars	Percent sucrose	Percent starch	Percent reducing sugars	Percent sucrose	Percent starch
July										
14	2	1.90	2.33	.18	2.74	.97	.54	2.56	3.64	4.79
16	4	1.18	4.22	.29	1.08	.65	2.88	.72	2.72	8.46
18	6	1.64	7.36	.11	2.84	2.01	5.60	1.54	5.01	9.61
20	8	2.72	1.26	.44	2.98	2.96	.54	2.23	10.49	8.12
22	10	2.94	1.18	.16	4.37	3.85	1.37	2.44	12.30	5.15
24	12	2.45	2.36	4.59	4.78	3.69	1.64	1.98	9.46	1.94
26	14	2.53	2.10	.11	4.68	8.50	2.21	1.54	15.85	11.74
28	16	2.71	.60	.54	2.90	2.96	.54	1.37	6.59	8.91
30	18	4.44	.87	.20	4.23	3.22	1.10	1.73	6.28	5.81
August										
1	20	3.35	.31	.41	2.63	3.84	.61	.94	4.01	5.58
3	22	3.32	.21	.13	1.61	3.12	.58	.54	3.56	13.05
5	24	1.54	.77	4.27	.90	1.35	.32	.31	2.18	15.86
7	26	1.44	.40	2.03	.71	.49	2.61	.22	2.55	24.37
9	28	1.06	.00	2.52	1.39	2.19	3.28	.14	1.93	18.14
11	30	.88	.05	6.50	1.18	1.62	7.15	.04	1.62	20.72
13	32	.78	.00	.34	.65	.12	2.47	.17	1.47	22.91
15	34	...	.....	...	.38	.00	.68	.18	1.36	21.76
17	36	...	...	...	....	....	....	.15	1.48	29.66

The variations in the sucrose content of the component plant parts are given in Figure 5. The sucrose content in the leaves reaches a maximum 6 days after heading, and then decreases more or less uniformly up to maturity. The maximum in the culms occurs 8 days later or 14 days after heading, and from then on to maturity a definite loss occurs. It is of interest to note that almost in every case the high and low sucrose contents of the leaves and culms respectively are 8 days apart. If this is a matter of translocation, it would indicate that 8 days elapsed between the time of maximum content in the leaves and the building up of a maximum content in the culm. The sucrose content of the heads increases up to 14 days after heading when the kernels are in the milk stage, and then rapidly declines to 4 days before maturity, assuming equilibrium from then on. The per cent sucrose in the heads

greatly exceeds the amount contained in either the leaves or culms throughout the growing period, with the exception of the first 6 days after heading.

The distribution of the starch indicates wide fluctuations in all the plant parts. The general trend however indicates a rapid increase in the starch content of the head samples with approaching maturity, and an increase in the per cent starch of the leaves and culms during the last stages of ripening and desiccation.

An attempt was made to correlate the fluctuations in carbohydrate content from day to day with the meteorological conditions for corresponding days. No significant correlations were obtained, possibly due to the fact that climate is a complex of many factors, and that the effect of particular climatic conditions on plants is accumulative, thus tending to obscure the immediate effect.

From the data on reducing sugars and sucrose, it is evident that the vegetative portions of the plant in the earlier periods of development actually manufacture sugars and translocate them to the kernel faster than the endosperm cells are able to synthetize them into starch, but in the later stages starch formation proceeds at a relatively more rapid rate and the percentage of sucrose and reducing sugars decrease rapidly in all the parts.

Conclusions

Subject to the environmental conditions under which this investigation was conducted, the following conclusions can be made.

(1) No significant reduction in either yield per acre or weight per 1000 kernels results from harvesting O.A.C. 21 barley one week before maturity.

(2) Considerable fluctuation occurs in the per cent dry matter of the component plant parts for different periods; in general, the trend shows a definite increase with approaching maturity.

(3) The per cent ash in the leaves and whole plant samples tends to decrease with approaching maturity, while in the heads a rise, followed by a period of uniform content up to the 18th day, and then a decrease to maturity was observed. The decrease in the culms continues to the 24th day after heading, followed by an increase to maturity.

(4) A steady decrease in per cent protein of the leaves and culms takes place up to maturity. The heads decrease in per cent protein until the kernels are in the soft dough stage, but from this time on a slight increase takes place.

(5) The per cent reducing sugars increases to a maximum in the leaves up to the firm dough stage, and in the culms and heads up to the milk stage, with a subsequent rapid decline to maturity in all three parts.

(6) The maximum sucrose content of the culms and heads occurs when the kernels are in the milk stage, or 14 days after heading, while in the leaves the maximum is reached about one week previous to the high point in the culms and heads.

(7) The general trend of the per cent starch in the head samples indicates a rapid increase with approaching maturity, while in the leaves and culms an increase is noted during the last stages of ripening and desiccation.

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REFERENCES

1. American Association of Cereal Chemists. Methods for the Analysis of Cereals and Cereal Products. Lancaster Press, Inc. 1928.
2. ARNY, A. C. and SUN, C. P. Time of cutting wheat and oats in relation to yield and composition. Journ. Amer. Soc. Agron. *19:* 410-439. 1927.
3. Association of Official Agricultural Chemists. Official and Tentative Methods of Analysis. Third Edition. 1931.
4. BEDFORD, S. A. The cutting of wheat at different stages of ripeness. Can. Dept. Agric., page 286, C.E.F. Report. 1894.
5. BRENCHLEY, W. E. The development of the grain of barley. Ann. Bot. *26:* 903-928. 1912.
6. BRENCHLEY, W. E. and HALL, A. D. The development of the grain of wheat. Jour. Agri. Sci. *3:* 195-217. 1903.
7. Canada Year Book. Pages 218-224. 1931.
8. FAGAN, T. W. and WATKIN, J. E. The distribution of the nitrogenous and mineral constituents in the oat plant at different stages of growth. Welsh Journ. of Agri. *7:* 229-246. 1931.
9. FISHER, R. A. Statistical Methods for Research Workers. Third Edition, Oliver & Boyd, Edinburgh, 1930.
10. HARLAN, H. V. and POPE, M. N. The moisture content of barley kernels during growth and maturation. Journ. Agri. Res. *23:* 333-360. 1923.
11. KEISSELBACH, T. A. Winter wheat investigations. Neb. Agri. Exp. Stat. Res. Bul. 317. 1925.
12. MCROSTIE, G. P. Report of the Division of Forage Crops. Dom. Dept. Agr., C.E.F. 1924-25.
13. THATCHER, R. W. The progressive development of the wheat kernel. Journ. Amer. Soc. Agron. *7:* 273-282. 1915.
14. WILSON, H. K. and RALEIGH, S. M. The effect of harvesting wheat and oats at different stages of maturity. Jour. Amer. Soc. Agron. *21:* 1057-1078. 1929.
15. WOODMAN, H. E. and ENGLEDOW, F. L. A chemical study of the development of the wheat grain. Jour. Agri. Sci. *14:* 563-586. 1924.

THE RELATIVE SUSCEPTIBILITY OF CULTIVATED AND NATIVE HOSTS IN ALBERTA TO STRIPE RUST[1]

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Obviously the relative susceptibility of our cultivated and native hosts to stripe rust in the field and their distribution in nature have an important bearing on the epidemiology of this rust in Western Canada. In a previous article (*3*) the significance of *Hordeum jubatum* in the development and distribution of this rust was mentioned. The following additional information regarding other hosts is now briefly presented.

Cultivated Hosts

Data obtained from uniform stripe rust nurseries located at the Dominion Experimental Farms at Lethbridge and Lacombe, the Provincial Schools of Agriculture at Claresholm, Olds and Vermilion, the Dominion Irrigation Station at Brooks, and at the University of Alberta, Edmonton, and from readings of varietal plots of wheat at the Olds and Lethbridge stations, indicate that while a number of varieties of wheat are susceptible

Table 1.—*The average reaction of varieties of wheat and barley to stripe rust in uniform nurseries located at stations in central and southern Alberta. Readings made subsequent to heading stage.*

Variety	Infection Rating† '27	'28	1929						1930						1931					
	O*	O	C	B	O	L	E	V	C	B	O	L	E	V	C	B	O	L	E	V
White Federation	l	l	m	l	t	o	o	o	m	l	m+	o	o	o	o		o	o	o	o
Bunyip	t	t	m	l	t	o	o	o	m	m	h	o	o	o	o		o	o	o	o
Marquis 7	t	t	o	t	o	o	o	o	m–	m+	h	o	o	o	o		o	o	o	o
Early Baart	t	t	l	l	t	o	o	o	m	m+	h	o	o	o	o		l–	o	l–	o
Chagot	h	h	m	m	l	o	l	o	m+	h+	h+	o	l	o	o		l	l	l	o
White Beardless Barley	–	–	o	t	o	o	o	o	o	t	o	o	o	o	o		o	o	l–	o
Bishop	t	t	t	t	o	o	o	o	o	t	m	o	o	o	o		o	o	o	o
Vermilion	t	t	t	t	o	o	o	o	m	l	h	o	o	o	o		o	o	o	o
Early Red Fife	t	t	t	o	o	o	o	o	o	l–	l	o	o	o	o		o	o	o	o
Chagot	–	h	h	m	m	o	l	o	m	h+	h+	o	l	o	o		l	l	l–	o
Early Java	t	t	m	t	t	o	o	o	o	m+	l–	o	o	o	o		o	o	o	o
Little Club	l	t	l	l	o	o	o	o	m	h	l–	o	o	o	o		o	o	o	o
Prelude	t	t	l	t	t	o	o	o	m	m	m	o	o	o	o		o	o	o	o
Marquis 10B	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	o	o	o
Chagot	m	h	h	m	l	o	l	o	m	h	h+	o	l	o	o		l	l	l–	o
Garnet	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	o	o	o
Reward	o	o	o	o	o	o	o	o	o	o	l–	o	o	o	o		o	o	o	o
O.A.C. 21 Barley	–	–	o	o	o	o	o	o	o	m	h+	o	o	o	o		o	o	o	o

*O, Olds; C, Claresholm; B, Brooks; L. Lacombe; E, Edmonton; V, Vermilion.

†t, trace; l, light; m, medium; h, heavy.

1A contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada, co-operating with the Department of Field Crops, University of Alberta.

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to *Puccinia glumarum*, those most extensively cultivated in the prairie provinces were for practical purposes resistant under prevailing field conditions during the years 1928 to 1931 inclusive.

Uniform nurseries containing susceptible varieties were planted at intervals from about May 1 to July 1 in order to have green plants exposed to infection until late September. The position of the varieties in these nurseries and the average rating obtained in 1929, 1930 and 1931 are given in Table 1, together with ratings on the same varieties at Olds in 1927 and 1928.

As the primary purpose of the uniform nurseries was to determine whether stripe rust spread more readily on cultivated hosts than on native ones, most of the varieties used were known to be susceptible. Marquis 10B (Ottawa selection), Garnet, and Reward were included for test because they are extensively grown in Alberta. The others, with the possible exception of Vermilion and Little Club, are to be found only at experimental stations. Chagot was easily the most susceptible, for *P. glumarum* was always found on this variety if it appeared in the nursery. Other varieties were less rusted in proportion to the infection on Chagot. It was concluded that reasonably reliable data on the susceptibility of varieties of wheat could be obtained in these nurseries only under very favourable conditions for stripe rust, which include an abundance of uredospores close at hand. This is well illustrated by the uneven and indefinite reaction obtained at Olds, Lacombe, Edmonton and Vermilion in 1929, 1930, and 1931. In other words, stripe rust may be common on native hosts in the vicinity yet produce little or no evidence of its presence on susceptible varieties of wheat in such nurseries.

It is interesting to observe in Table 1 that Marquis 10B was decidedly resistant, while Marquis 7, another selection, was quite susceptible. Only one case of stripe rust was observed on Reward and none on Garnet. Of the two varieties of barley tested OAC 21, which is commonly grown, was very susceptible, while White Barbless, rarely grown, was slightly susceptible.

Stripe rust was not observed on the following varieties of wheat in nurseries at Olds during 1927 and 1928, when it was prevalent: Red Robs, Early Red Fife, Supreme, Quality, Dicklow, Kitchener, Garnet, Marquis 10B, Ruby, Bobs 222, Sunset Ca. 3015, Hard Federation CI. 4733, Monad CI. 3220, Velvet Chaff, Percy, Red Chaff, Pioneer, Preston, Red Club, Khahla, Red Russian, Polish, Acme, Defiance, Huron, Blue Stem, Kobben, Egyptian, Ceres, Duchess, Major, Producer, Axminster, Marquillo, Speltz, Emmer, and Einkorn. Each plot of the above was repeated three times.

P. glumarum was not found on the following varieties at the Dominion Experimental Station at Lethbridge, in 1930, under reasonably good conditions for infection: Early Red Fife, Kitchener, Marquis 10B, Reward, Quality, Supreme and Dicklow. It was found on Mindum, Apollo, Planet, Reliance, Segalstad and Marquis 7.

Obviously the foregoing data do not indicate that the varieties listed are definitely susceptible or resistant under all conditions, or at all stages

of growth, or that strains within the varieties may not be found which are susceptible or resistant, but are merely an indication of their reaction under reasonably favourable field conditions for infection. However, only a few of the many varieties listed were susceptible to *P. glumarum,* and many of these only slightly. Of special interest is the fact that Marquis 10B, Reward and Garnet, commonly grown in Alberta, have been definitely resistant to stripe rust. Data are not available regarding resistance of Renfrew, Kitchener and Red Bobs, which are grown mostly in southern Alberta and to some extent farther north. However, since severe or even slight infections of stripe rust have been observed rarely to date in varieties of wheat as they occur in field culture throughout Alberta, it would seem that even these may not have been very susceptible under climatic conditions from 1928 to date, and that wheat does not aid to any perceptible extent the annual incidence of stripe rust here.

Native Hosts

An indication of the relative susceptibility of certain native and introduced hosts is shown in Table 2. This data was made available through the courtesy of Dr. J. R. Fryer of the University Department of Field Crops, whose grass nursery and the records of its population we used. Readings were made Otcober 12th, 1931, on individual plants of the various selections listed. As most of the native selections were derived from seed of plants collected in various parts of Alberta, the data obtained regarding their reaction to stripe rust should indicate fairly closely the relative susceptibility of the species as found in nature. However, in the absence of more definite information regarding physiological races of *P. glumarum* which might be present from year to year, final conclusions cannot be made. On the other hand, observational evidence strongly suggests that *P. glumarum,* commonly found on *H. jubatum* also goes to wheat and the *Agropyrons,* including *A. Richardsoni, A. tenerum, A. dasystachyum, A. Smithii,* and *A. Griffithsii.*

The individual plants were in rows three feet apart each way. Favourable moisture and temperature and an abundant supply of natural inoculum distributed throughout the nursery were all factors in producing apparently ideal conditions for a rigid test. Each plant was placed in classes according to reaction and all the plants of each selection given a rating in percentage. Values of 1, 2, 3, 4 and 5 were given for trace, slight, light, medium and heavy, respectively. Finally all the plants of each species were give a total rating in percentage, for comparing the relative susceptibility to *P. glumarum* of the various genera and species tested.

The selection of *H. jubatum* L., which was not located in this nursery but near it, and the only selection of *Bromus ciliatus* L., included in the nursery, were each given full infection rating. All the selections of *A. dasystachyum* (Hook) Scribn. were consistently susceptible, only one being below 54%, while together they gave a total rating of 64%. There was considerable individual diversity in susceptibility among the selections

of native *A. Richardsoni* (Trin.) Schrad., the ratings varying from 2 to 100%, but the average rating for all being 59%. All native selections of *A. Griffithsii* Scribn. and Smith and *A. spicatum* (Pursh) Scribn. and Smith and introduced selections of *A. dasystachyum*, *A. Sibericum* (W.) Eichw. and *A. cristatum* L. Gaertn. were uniformly susceptible, falling into infection ratings between 48 and 55%. There was a distinct decrease in the susceptibility of native selections of *A. Smithii* Rydb., the average rating of all plants being 27%.

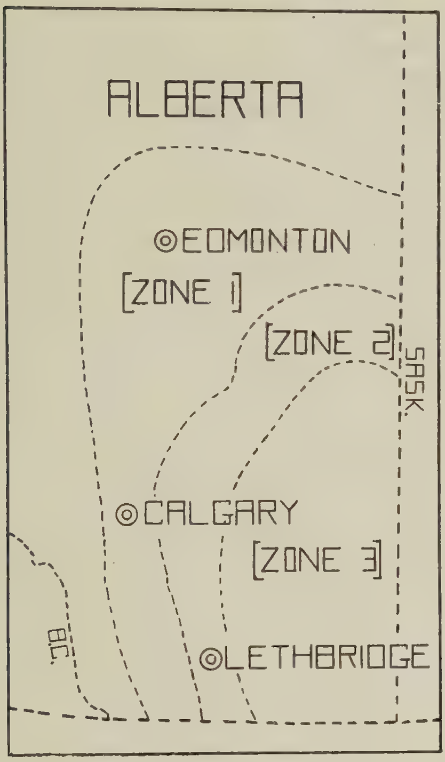

Figure 1. A section of Alberta indicating stripe rust zones I, II and III. In order given, these areas roughly approximate the black, transition and brown prairie soil belts as outlined by the University of Alberta Department of Soils.

It is very interesting to note the great diversity in susceptibility among 14 native selections of *A. tenerum* Vasey, from Alberta and the three native ones from Saskatchewan. Of the 14 selections from Alberta, 9 were distinctly resistant, while of the remaining 5 the infection rating of 3 varied between 30 and 58%, while 2 were 24%. The average rating for all selections of *A. tenerum* was 16%. If the native selections could be considered as an approximate random sample from nature, indications are that this species is, in general, distinctly less susceptible than *A. Smithii*, which agrees with observations made on survey. Of the native selection comprising 10 plants of *A. repens* L. Beauv., one plant was very heavily rusted, while the others were free. Also there were susceptible and apparently resistant plants in each of two native selections of *A. caninum*. *P. glumarum* was found on introduced selections of *A. elongatum* Host., *A. dagnae* Grossh., *A. pungens* (Pers.) R. & S., but, as in the case of *A. repens* and *A. canium*, the number of plants was too limited for comparing the relative susceptibility of the species. Apparently *A. repens*, *A. elongatum*, *A. dagnae* and *A. pungens* have not been reported previously as hosts for *P. glumarum*. *A. junceum* (L.) Beauv., *A. glaucum* Roem. and Schutt. and *A. obtusiusculum* Lange, all introduced selections, were not infected.

Distribution of Native Hosts

Of the native hosts in Alberta *H. jubatum* is outstanding, both in susceptibility to *P. glumarum* and in prevalence, being found throughout the settled parts of Zones I, II and III (Figure 1). It occurs in and about sloughs, around farm buildings, along highways, and in fields. It is

TABLE 2.—*The relative susceptibility or resistance of individual plants of various selections of native and introduced grasses to P. glumarum in a grass nursery,**
University Plots, Edmonton, October 16th, 1931.

Unit	Host	Plants	Infection							Source
			Classes†						%	
			O	T	S	L	M	H		
1	*Hordeum jubatum*	10						10	100	Edmonton, Alta.
2	*Bromus ciliatus*	4						4	100	" "
3	*Agropyron dasystachyum*	10		1	4	2	1	2	58	Raley "
4	" "	7	1	3	3				26	Granum, "
5	" "	10			2	1	1	6	82	Calgary, "
6	" "	9			1	2	1	5	82	Glenwood, "
7	" "	9			1	3		5	80	Cardston, "
8	" "	10		1	4	1	1		54	Lethbridge, "
9	" "	10		1	1	1	4	3	74	Nanton, "
		65	1	6	16	10	8	21	63	
10	*Agropyron Richardsoni*	9						9	100	Birdsview, Sask.
11	" "	10				5	3	2	74	" "
12	" "	10	2	3	1	1	2	1	42	Millet, Alta.
13	" "	9						9	100	" "
14	" "	10				3	6	1	76	" "
15	" "	10	9	1					2	Onoway, Alta.
16	" "	10	1	3	2	1	1	2	48	Cardston, Alta.
17	" "	10	4	5	1				18	" "
18	" "	10				1	7	2	82	" "
		88	16	12	4	11	19	26	59	
19	*Agropyron Griffithsii*	10					1	9	98	Staveley, Alta.
20	" "	9	3	4	1		1		22	Glenwood, Alta.
21	" "	10		3	4	2	1		42	" "
		29	3	7	5	2	3	9	55	
22	*Agropyron desertorum*	10		3	4		1	2	50	Russia
23	" "	9		2			1	6	80	"
24	" "	10		2	1	1	4	2	66	"
25	" "	7		3		1	1	2	57	"
26	" "	9		2	6		1		40	"
27	" "	10	1	5	3		1		30	"
28	" "	7		2	1	2	1	1	54	"
		62	1	19	15	4	10	13	54	
29	*Agropyron spicatum*	9	3	1		4		1	40	Waterton Lakes, Alta.
30	" "	2				2			60	" " "
31	" "	3					3		80	" " "
		14	3	1		6	3	1	51	
32	*Agropyron sibericum*	10	(Foliage cut, no rating; infection general; some heavy)							Russia
33	" "	10								Siberia
34	" "	10								Denmark
35	*Agropyron cristatum*	8	1	1	3	2	1		42	Russia
36	" "	7	3	1		1	2		34	"
37	" "	9	1	1	1	1	3	2	62	"
		24	5	3	4	4	6	2	48	
38	*A. Smithii*	8	1	4	1	1	1		33	Manyberries, Alta.
39	" "	6		3	3				30	Medicine Hat, Alta.
40	" "	7		7					16	Lethbridge, Alta.
41	" "	8	1	4	3				25	" "
		29	2	18	7	1	1		27	

TABLE 2.—*Continued*

Unit	Host	Plants	Infection							Source
			Classes†						%	
			O	T	S	L	M	H		
42	*A. dagnae*	1		1					20	Russia
43	*A. pungens*	1		1					20	England
44	*A. caninum*	10	10						0	Denmark
45	" "	7	5	1			1		14	"
46	" "	2						2	100	Alberta
		19	15	1			1	2	16	
47	*A. tenerum*	9		2	6	1			38	Trossachs, Sask.
48	" "	10	1	6	3				24	Bow Island, Alta.
49	" "	10	7	3					6	Edson, Alta.
50	" "	6	3	1	2				17	Olds, Alta.
51	" "	10	10						0	" "
52	" "	7	7						0	Niton, Alta.
53	" "	10	6			4			24	Calahoo, Alta.
54	" "	10	10						0	Wolf Creek, Alta.
55	" "	10	10						0	Winnipeg, Man.
56	" "	11	5					6	55	" "
57	" "	10	8	2					4	MacKay, Alta.
58	" "	10	10						0	Cardston, Alra.
59	" "	7	7						0	Ardley, Alta.
60	" "	6	6						0	Ponoka, Alta.
61	" "	9	9						0	Russia
62	" "	10	5			1	4		58	Alberta
63	" "	10	5	1	2	2	1	1	40	"
64	" "	12	2	4	4	2			30	"
		167	111	19	17	10	5	7	16	
65	*A. repens*	10	9					1	10	Trossachs, Sask.
66	*A. elongatum*	9	8	1					2	Saskatoon, Sask.
67	*A. junceum*	2	2						0	Denmark
68	*A. obtusiusculum*	7	7						0	California
69	" "	8	8						0	Denmark
70	" "	15	15						0	"
71	*A. glaucum*	1	1						0	"

* Access to this nursery and the records of its population by courtesy of Department of Field Crops, University of Alberta.

† O, absent; T, trace; S, slight; L, light; M, medium; H, heavy.

particularly common in Zone I; less common in Zone II, and, except in sloughs, still less common in Zone III. Further, this is the grass on which *P. glumarum* is first found when it is apparently absent from other susceptible species in the vicinity. *A. Richardsoni* is found mainly throughout the park and adjacent wooded areas in Zone I in north-central Alberta, and farther north and west, and in the park areas of Saskatchewan. To a limited extent it also occurs in the extreme south of Zone I near the foothills. Apparently this host is not very commonly rusted in Alberta.

A. dasystachyum and *A. Smithii* are fairly common in Zones I, II and III. In Zone I they are mostly restricted to the southern and eastern

sections. Both hosts occur on the upland, where conditions are often too dry for best infection, particularly during late August and September, when the foliage has usually reached maturity. Observational evidence has been that *A. Smithii* rarely has more than a slight amount of stripe rust in nature, while *A. dasystachyum* is much more susceptible and more frequently rusted there. *A. Griffithsii* also occurs in southern Alberta in Zone I. *A. tenerum* occurs commonly in the northern parts of Zones I and II, the distribution being similar to that of *A. Richardsoni*. Under natural conditions very little stripe rust has been observed on it to date. The possible explanation is that the foliage like that of *A. Richardsoni* and to some extent *A. dasystachyum*, has often ripened by early September, when stripe rust develops best. The green foliage of *A. Smithii* usually persists longer. In the case of *H. jubatum* the green succulent foliage of the younger seedlings persists during September until killed by frost. Such plants, as well as older ones growing in a moist habitat, appear to be the principal carriers of stripe rust during September. *Bromus ciliatus* occurs rather commonly throughout the northern part of Zone I of Alberta, and this is the first record of stripe rust on it in Canada. Of the susceptible species of *Bromus* listed by Hungerford and Owens (*2*) *B. inermis* Leyss., *B. tectorum* L., *B. ciliatus* L. and *B. hordeaceus* L. occur naturally in Alberta. With the exception of *B. ciliatus* (natural infection), stripe rust has not yet been observed on these here. Of the susceptible species of *Elymus* listed by Humphrey et al (*1*), *E. canadensis* L., *E. condensatus* Prest., *E. robustus* Scribn. and Smith and *E. virginicus* L. are known to occur naturally in Alberta, but *P. glumarum* has not yet been collected on any of them.

Resistant Strains of Native Hosts

Examination of the results in Table 2 indicates that there exists in nature strains of the various species of *Agropyron* which differ widely in their resistance to the race or races of *P. glumarum* present, some apparently being immune. Probably a larger number of native selections than were used would be required to indicate more definitely the situation in nature. However, the results obtained suggest that the selections of *A. dasystachyum* and *A. Griffithsii* were more consistently susceptible than *A. Smithii* and decidedly more so than either *A. Richardsoni* or *A. tenerum*, in which there were strains particularly resistant. In this regard it would be of particular interest to know how general natural resistance to *P. glumarum* is in *H. jubatum* in nature.

Summary

Hordeum jubatum is, unquestionably, the principal host in the initiation, development and spread of stripe rust in Alberta, being extremely susceptible, widely distributed and prevalent. As such it appears to be the most suitable host for epidemiology studies in nature.

Agropyron dasystachyum, because of its uniform susceptibility, and fairly common distribution in Zone I, southern Alberta, where stripe rust develops first, and also its occurrence in the same zone in east central Alberta, appears to be next in importance to *H. jubatum*. *A. Griffithsii*

might be given equal rank for the same reason, but it does not seem to be as common as the former host.

A. Richardsoni is, on the whole, as susceptible as *A. dasystachyum* and may be an important host in the central and eastern parts of Zone I. Collections from nature differed widely in susceptibility, some being very resistant or immune, while others were very susceptible.

A. Smithii, although uniformly moderately susceptible, can hardly be classed as important in the distribution of stripe rust since it indicated only slight susceptibility under the most favourable conditions for test, and in nature its reaction is usually negative or only slightly susceptible.

A. tenerum, as it exists in nature in Alberta, appears to be moderately susceptible, and often apparently very resistant or immune.

One plant only of *A. repens* was found rusted. This was very susceptible. All plants of a selection of *Bromus ciliatus* were very susceptible.

Apparently *A. repens, A. elongatum, A. dagnae* and *A. pungens,* which were rusted, have not been reported previously as hosts for *P. glumarum.*

The varieties of wheat, as now commonly grown in Alberta, are resistant or immune for practical purposes. These include Marquis, Reward and Garnet.

REFERENCES

1. Humphrey, H. B., Hungerford, C. W. and Johnston, A. G. Stripe rust (*Puccinia glumarum*) of cereals and grasses in the United States. Journ. Agr. Res. *29:* 209-227, 1924.
2. Hungerford, C. W. and Owens, C. E. Specialized varieties of *Puccinia glumarum* and hosts for variety *tritici.* Journ. Agr. Res. *25:* 363-401. 1923.
3. Sanford, G. B. and Broadfoot, W. C. Epidemiology of stripe rust in Western Canada. Sci. Agr. *13:* 77-96. 1932.

SOME RECENTLY NOTICED MUSTARDS[1]

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[Received for publication November 5, 1932]

An important function of the Canadian Weed Survey of the Division of Botany, Central Experimental Farm, Ottawa, is to detect and call attention to newly appearing weeds. From time to time through correspondence and brief published notes the more important additions to our weed flora have been announced. Many other apparently interesting records await the additional study necessary first to preclude danger of erroneous conclusions. It is not always easy to secure the information required nor, unfortunately, the time from other duties to pursue it systematically.

Among the weeds receiving attention during 1932 are some which have not been recorded previously in Canada, although in some cases evidently not entirely new. We are still dependent largely, for the location of newcomers, upon the chance receipt of specimens from local observers or other workers. It is even possible, as will appear, for an unfamiliar weed to masquerade for quite a time under a cloak of resemblance to another species before the suspicions of otherwise preoccupied botanists are aroused. This is eminently true of the species to be first discussed here.

Erucastrum gallicum (Willd.) O. E. Schulz. (Dog Mustard)

About a year ago specimens were received from Manitoba and also from Ontario, which at first we believed to be a *Sisymbrium*, but of a species not known to be in the country. During field work in 1932 the same weed was encountered in so many places and over so wide a territory east and west, that doubt was cast upon our previous assumptions, to such extent that a further study has been made of the ample material now available. The weed has now been identified here, and the identification confirmed at the Gray Herbarium, Harvard University, as *Erucastrum gallicum* (Willd.) O. E. Schulz, a European species which has been known in the United States for some years (under the name *E. Pollichii* S. & S.). In 1911 (*1*) Dr. B. L. Robinson published the first American records; one, dating back to 1903, from Wisconsin, and the other, which was the immediate occasion of the note, from Massachusetts. Subsequent records have become fairly numerous, ranging by 1924, (*2*) from West Virginia to Western North Dakota, and now (*3*) as far west as Glacier Park, Montana.

That no Canadian records have appeared is owing not to any recency of advent, but to failure until now to recognize the true identity of plants received and collected. The earliest specimens were not good material for study, and when named at all were dubiously referred to *Diplotaxis tenuifolia* (L.) D.C.—once to *Sisymbrium Loeselii* L.—, nothing being published in view of the doubt remaining. Later collections either awaited naming, or passed as *Diplotaxis*, which genus long accomodated species now considered

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better separated from it. A European specimen of the plant under discussion, found in the National Herbarium, Ottawa, under the name *Diplotaxis bracteata* Gren. & Godr., was one of the clues by means of which our difficulty was finally cleared up.

The history of *E. gallicum* in Canada so far as it can be outlined from specimens in the Division of Botany Herbarium is as follows:

Emerson, Man., July 11, 1922. (H. Groh). The specimens were laid aside unnamed and have only now come to light again to stand as an earliest known record for Canada. That this should come from a point on the International Boundary, near which the adjoining State has various records dating from 1909 onwards, is suggestive even if not constituting any proof of the direction of spread. Fargo, N.D., Grand Forks, N.D., Emerson, Man., and later on Winnipeg, Man., all on the well travelled Red River route, are a succession of places and dates worth noting at least.

Peterboro, Ont., July 31, 1924. (G. L. Crowley). Efforts to get better material from the sender, or even to locate him during a visit to Peterboro, were without avail.

Treherne, Man., Oct. 10, 1924. (Alfred Gates). It was considered a bad weed on his farm of some years standing already.

Meaford, Ont., August 25, 1925. (This and the following six collected by H. Groh as sporadic wayside weeds mostly in town).

Charlottetown, P E.I., July 29, 1926.

Kenogami, Que., Sept. 17, 1927.

Arvida, Que., Sept. 20, 1927.

Sherbrooke, Que., Sept. 24, 1927.

Preston, Ont., Aug. 23, 1928.

Winnipeg, Man., Sept. 28, 1929.

Guelph, Ont., Sept. 4, 1930. (J. E. Howitt & E. W. Hart). Well established in an orchard.

Golden Stream, Man., July 8, 1931. (Norman Criddle).

Ste. Rose, Man., Oct. 1931. (A. R. Judson). Reported as becoming of importance on farms in the district. This is the specimen which initiated the present investigation.

Coldbrook, N.S., June, 1932. (F. A. Wood). Specimen returned.

Ochre River, Kergwenan and Ste. Rose, Man., June 13, 1932. (A. R. Judson, J. Connor, and H. Groh). Roadside infestations traced over a distance of about fifteen miles, and various fields in crop heavily infested. Mostly still in seedling or early stages, but a few plants on packed roadway already in flower.

Laurier and Kelwood, Man., June 15, 1932. (H. Groh). No specimens retained. This would seem to be more or less continuous with the Ste. Rose area.

Winnipeg, Man., June 16, 1932. (This and all except the last collected by H. Groh). Rather general in the railway yards. Where growing with tumbling mustard it was not difficult to see how young plants might be passed over for that species.

Roseisle, Man., Jun 19, 1932. Roadside.

Boissevain, Man., June 20, 1932. Railway yards.

Brandon, Man., June 20, 1932. Railway siding.

Watrous, Xena, Young and Zelma, Sask., June 22, 1932; a distance of twenty-five miles, with considerable scattered a ong the road, and the principal field invasion near Xena, where a preference for the knolls of undulating land, and thin places in the crops was apparent. Road and railway infestations everywhere have been on bare or thinly covered ground.

Langham, Sask., June 23, 1932. Roadside.

Scott, Sask., June 25, 1932. Elevator siding. This is as far west as the survey was carried in 1932.

Kipling, Sask., June 28, 1932; a quarter mile of roadside and adjoining field infested.

Galt, Ontario, Aug. 22, 1932. Railway iding.

Coaticook, Que., Aug. 27, 1932. Railway yard.

Pointe aux Trembles, Que., Aug. 30, 1932. Railway track.

Kingston, Ont., Oct. 8, 1932. (W. G. Dore). In sand by elevator.

Although as well surveyed in recent years as other parts of Canada, the extremes of geographical range have as yet furnished only two stations. Even so, it must be confessed that the foregoing is rather an astounding array of records on which to base the discovery of a new weed. From Charlottetown, P.E.I. to Scott, Sask., is more than 2500 miles.

Figure 1. *Erucastrum gallicum.* Distribution in Canada as recorded to the end of 1932 season.

E. gallicum is distributed over much of Europe where the German name for it is Hundsrauke. In the United States this has been rendered into English as dog mustard.

Reference has been made to the affinity of this weed with *Diplotaxis*, which it somewhat resembles, but from which it differs in the uniserial arrangement of the seeds, and in the continuance of leafy bracts up into the inflorescence, an unusual thing in the Cruciferae, as Dr. Robinson has emphasized. The description presented in his paper (*1*) serves so well to convey an idea of the plant that it may be quoted in full. "Annual, erect or ascending, 2-4 dm. high, with habit somewhat as in *Sisymbrium altissimum:* stem retrorsely pubescent, the hairs being simple; leaves oblong in general outline, deeply pinnatifid to decidedly bipinnatifid, the lobes rounded, the sinuses broad and usually obtuse or truncate; racemes at length elongated, loose, the pedicels slender, ascending or so widely spreading as to be nearly horizontal, in fruit 6-10 mm. long, the lower ones subtended by distinct (though much reduced) leaves or leaflike bracts; flowers of medium size; petals pale yellow, 5 mm. in length; pods linear, subterete, 2.5—3.5 mm. long, 1-2 mm. in thickness, tipped with a slender style about 3 mm. long; seeds essentially in a single row in each cell." *Diplotaxis* has long been represented in Canada by the species *tenuifolia* and *muralis*, which are chiefly ballast, railway and waste weeds.

The genus *Erucastrum* is not to be confused with *Eruca*, one species of which, *E. sativa* figured prominently in the weed annals of a quarter of a century ago, when, having failed to establish itself, it disappeared as suddenly

as it came, after its channel of introduction, alfalfa seed from eastern Europe, no longer brought it. It was first reported in the summer of 1907 (*4, 5*) and was soon known from most of the provinces.

Sisymbrium Loeselii L. (Tall or Loesel's Hedge Mustard)

While the presence of this mustard in Canada was first suspected from the receipt of a plant which has now been shown to be *Erucastrum gallicum*, it is nevertheless present. In Aug. 1929, very incomplete specimens were received here through two channels, both tracing however, to one source, Stoney Beach, between Regina and Moosejaw, Sask. It has been collected there in the present year by Mr. W. G. Palmer of the Saskatchewan Department of Agriculture. It was also collected at Carlyle, Sask., June 27, 1932; and along the highway through the Brandon Hills, south of Brandon, Man., June 20, 1932. (In each case H. Groh).

In the latter location especially, on bare road embankments, the plants had reached strikingly large size, four or five feet in height and branched to a breadth of two or three feet. Although hairy below, the upper parts are mostly smooth. The leaves are large, and cut to the midrib into narrow lobes, except the terminal lobe, which is more or less cut and toothed and rather triangular in outline. The numerous medium sized flowers are bright yellow in colour, and are followed by slender pods upwards of an inch in length borne on pedicels one half inch long. The seeds are yellow, smooth, very small, and numerous.

There is no evidence as yet that this mustard is likely to be troublesome in fields. It has been in the United States, both east and west, for some years without occasioning alarm.

Rorippa (=Radicula) austriaca (Crantz) Besser

A specimen collected recently by Mr. Jas. Patmore, a Saskatchewan Weed Inspector, has been identified as Austrian Cress—*Rorippa austriaca* (Crantz) Besser, or a hybrid of that species. It was found growing as a perennial weed at Greenstreet, Sask., where it was believed to have come in an importation of seed from England. It is hardly possible to say yet that it is permanently established, although the sender feels occasion for concern. In Europe it has spread sufficiently from the eastern borders, where it is at home, to indicate weediness, but it is evidently confined largely to that continent and adjacent Asia. It appears to be there a plant of moist land.

Austrian cress is a tall-growing perennial, nearly smooth, with strap-like leaves clasping the stem, and without lobes or indentations other than the teeth. The flowers are yellow and rather small. The pods are small, globular and tipped by a persistent style.

A somewhat similar species *R. amphibia* (L.) Besser, has established itself firmly as a water weed at several points in the St. Lawrence River immediately below Montreal (*6*).

Another introduced species, which has already exhibited decidedly noxious qualities, is *R. sylvestris* (L.) Besser., commonly known as yellow cress. It is a perennial from creeping shoots or rootstocks, which are very difficult to destroy by ordinary tillage operations which do little but transplant the pieces. It invades fields and gardens in sandy moist locations

especially. Records in the Canadian Weed Survey are from scattered points from coast to coast, the earliest and most numerous being from Ontario.

Rapistrum spp.

Until 1928 the genus *Rapistrum* appears not to have been recorded in Canada. In September of that year specimens of a weed from Grenfell, Sask., submitted to the Division of Botany, Central Experimental Farm, proved to be *R. perenne* (L.) All. On July 30, 1932, *R. rugosum* (L.) All. was collected by the writer on vacant land along the waterfront in Montreal, Que. Thus within a few years two of the three species recognized as valid in Engler's Pflanzenreich (7) have been found in this country, the one perhaps merely as a ballast waif, but the other, *R. perenne*, securely established as a field weed. It has spread over parts of six quarter sections of farming land, according to Mr. L. J. Hutcheson, District Representative of the Saskatchewan Department of Agriculture, who accompanied the writer to the locality in June last.

R. rugosum has been recorded from New York City and from Staten Island (8). It is an annual of the general appearance of many of the mustards, and most readily distinguished in the field by the characteristic two-jointed pods of the genus. In its European home it is found in fields, waste places, waysides, etc. Where found in Montreal it has not become abundant, but several specimens were collected, one of which has been placed in the National Herbarium, the others in the Division of Botany.

R. perenne, which has become known in the Grenfell district as perennial rape, is said to have been present for ten years or more, and the extent of its spread to date would presuppose some little time. Although perennial it is dependent on its seed for spread, as the root does not extend laterally. It has an extraordinarily strong and deep tap-root, capable of budding freely at considerable depth. The plant above ground is equally coarse, becoming from two to three feet tall, widely branching, and at maturity often breaking off at the base to become a tumbleweed. The upper part of the plant, with its leaves, is smooth, but the lower stem and leaves are quite rough and hairy. The stem, when grasped, leaves the hands full of these hairs or weak bristles. The leaves are pinnately lobed like a much elongated oak leaf, with the deep lobes alternately arranged on the blade, and the total length including the short petiole, often seven or eight inches in the case of the lower ones. The branches of the inflorescence become gradually much elongated, and like the main stem, stiff and hard. When advanced in development they are found with a racemose tip of yellow flowers, and beneath these at intervals of an inch or so, the curious pods consisting each of a cylindrical lower joint and a somewhat conical upper joint. While only a seed or two is borne in each segment, the number on a plant can yet be considerable. The seeds are about a millimetre long, ovoid in shape, smooth and brown. For a full description of the plant it is necessary to consult European works.

Owing to the nature of the roots patches are not formed as with many perennials but plants stand isolated and conspicuous about a field. Much of the soil in this particular district is light sandy loam, and the weed shows some preference for the looser type of ground appearing, in the case of a stiff sod, around the burrows of rodents, and generally in more abundance

on knolls. In Europe it is reported to occur on fields, waysides, dry hillsides, and especially on loamy and limey soils. Its weedy character is recognized and the occasional spread of the seeds with grain is noted.

In the Grenfell district some attempts at eradication have been made. It is evident that something more than the regular tillage required in cropping will be necessary to kill these strongly entrenched roots; and while the infestation is still scattered this is possible. A chlorate weed killer has been used with encouraging results, applying it to the individual plants. One field was examined which had received treatment in 1931, and had been cleared of many plants; and among those left were weakened specimens in which the chemical was still working. One of these, after losing its main stem, had volunteered eight others which were traced to a depth of fifteen inches at which point they were reduced to three, evidently joining lower to one taproot. Some of these stems were blackening at the time, indicating that the chemical had reached their point of departure from the root system, and might yet reach the others. Any further effort to replace them with shoots from deeper healthy taproot would be against heavy odds.

From what we know already of perennial rape we may at least conclude that it is a weed which should be suppressed at whatever cost. It is a persistently deep and stout rooted perennial with ready means of recovery when cut off. The plant is coarse occupying much space in crops, and creating difficulties in binding as well as in tillage. The pods approximate in size the grain in which they will be found, and may well carry the weed to fresh locations, as will also the tumbling plants. It is to be hoped that new infestations will be reported promptly to either the Provincial or the Federal Departments, so that proper measures may be taken in time.

The mustard family has already given us many of our most pernicious weed pests. It is scarcely to be expected that others only now appearing are likely to be among the worst; but we have no guarantee that changing trade currents, or other circumstances, may not at any time create opportunities, hitherto lacking, for such to disperse themselves in our direction. It is at least the part of wisdom to be alert to potential dangers, and aware of what is trying out its resources for survival in our midst.

REFERENCES

1. Robinson, B. L. *Erucastrum Pollichii* adventive in America. Rhodora *13:* 145. 1911.
2. Blake, S. F. *Erucastrum Pollichii* in West Virginia. Rhodora *26:* 301. 1924.
3. Standley, P. C. Records of United States Plants chiefly from the Chicago region. Rhodora *34:* 405. 1932.
4. Macoun, J. M. *Eruca sativa* Mill. Ott. Nat. *21:* 8. 1907.
5. Groh, H. Another locality for *Eruca sativa*. Ott. Nat. *21:* 9. 1907.
6. Marie-Victorin, Frere. Le genre *Rorippa* dans le Quebec. Contr. Lab. Bot., Univ. Montreal. No. 17. 1930.
7. Engler, A. Das Pflanzenreich. IV. 105. Cruciferae-Brassiceae-Subtrib. 1 et 2 von O. E. Schulz. 1919.
8. House, H. D. Annotated list of the Ferns and Flowering Plants of New York State. N. Y. State Mus. Bul. 254. 1924.

YAROVIZATION OR VERNALIZATION OF CEREAL CROPS

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According to some recent investigations with cereals, it was reported possible to mature and augment yields through artificial stimulation. Lyssenko, a Ukrainian plant breeder, illustrated in Der Zuchter (*1*) some very striking and conclusive results. The research work in connection with the adaptation of cereal crops ultimately rewarded the above investigator with a notable achievement, namely, to mature plants 10-35 days earlier and at the same time to increase their yields.

Figure 1. Kharkov Winter Wheat. Two pots on left from seed subjected to pre-germination treatment, including soaking and storing in darkness for 31 days at 40° F. and 21 days at 27° F. respectively. Pot on right untreated.

Lyssenko's original "Yarovization" has recently been anglicized by R. O. White and P. S. Hudson of the Imperial Bureau of Plant Genetics, whence the name "Vernalization". The term implies pretreatment of seed which consists of soaking the same in water until the germ swells conspicuously (approximately 16 hours), and exposing it to a temperature of 27° F. to 40° F. for 6 - 30 days in darkness. The periods of cold and darkness vary with the varieties of winter and spring cereals. Further reference to the above investigation has been made in two numbers of the Journal of Heredity (*2*, *3*).

In order to appreciate the above investigation and gain full advantage therefrom, the Cereal Division, Central Experimental Farm, has conducted a preliminary experiment with winter and spring cereals. After carefully

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observing all stages of plant growth under greenhouse conditions, it was considered advisable to report that the results in general have proven similar to those obtained by Lyssenko. The accompanying photograph illustrates the effectiveness of Yarovization, according to Lyssenko's process, in enhancing the maturity of winter wheat under greenhouse conditions at Ottawa.

The field experiment which is being conducted involves a pre-treatment of seed at different temperatures and varying periods of exposure in darkness. The Cereal Division contemplates reporting some definite data in this connection after summarizing the additional field results.

REFERENCES

1. Sapehin, A. A. The importance to the breeder of the shortening of the vegetative period by the methods of T. D. Lyssenko. Zuchter *4:* 6; 147-151. Berlin, 1932.
2. Bruman, A. J. "Yarovization"—A new factor in plant breeding technique. Jour of Heredity, *23:* 11; 465.
3. McKinney, H. H. and Sando, W. J. Russian methods for accelerating sexual reproduction in wheat. Jour. of Heredity, *24:* 4; 165.

MORPHOLOGIE UND GRUPPIERUNG DER DEUTSCHEN WEIZENSORTEN. (Morphology and Classification of German Wheat Varieties.) Dr. John Boss. Biologischen Reishsanstalt fur Land- und Forstwirtschaft, Berlin-Dahlem, Germany. Price 9 R.M.

This publication covers in a most interesting and thorough manner a morphological description and classification of German wheat varieties (112 pages of text and 30 additional pages of cuts.) The reliability of the different morphological characters used in distinguishing varieties is put to a most severe test by the author, who realizes that the value of these characters for the above purpose depends essentially upon their constancy under widely varying conditions of soil and climate.

Both the taxonomist and geneticist should find this work extremely useful, as should also those who are interested in the characteristics of European wheat varieties.

—L. H. Newman

NOTES ON INSECT POLLINATORS IN NOVA SCOTIA ORCHARDS

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[Received for publication June 17, 1933]

During the past five years extensive records have been made of the wild bee population of various orchards in the Annapolis Valley, Nova Scotia (*1*). During the first four years of these studies, solitary bees of the genera Andrena and Halictus were present in adequate numbers, in the average orchard, alone to effect the pollination of the apple bloom. During the fifth year, however, there was a pronounced decrease of these insects with indications of a further decrease the following season.

This indication appears to be borne out by counts made in a certain number of orchards during the current year. In the Kentville Experimental Station Orchard where colonies of honey bees were scattered throughout the orchard, nine ten-minute counts gave 18 honey bees and 1 Halictus sp. In another orchard at Port Williams two ten minute counts failed to produce a single bee. Two further counts at Lower Canard gave 6 solitary bees. At Woodside no insects were found in two ten-minute counts. At Canning one count gave no insects, although a few were seen in other parts of the tree. At Sheffield Mills one count gave nothing. During the counts conditions for insect activity from the standpoint of temperature and sunlight were fair to good. These observations while inadequate to give a complete picture of the situation throughout the bloom do appear to indicate that the recession noted last season is even more pronounced this year. Furthermore, reports from several individual orchardists indicate a like condition in other parts of the district.

The foregoing brief notes emphasize the inadequacy of the five year period to cover the complete cycle of insect pollinators. In view of the almost complete absence of commercial apiaries in the fruit belt the effect of the foregoing conditions upon the fruit set will be awaited with interest. The condition noted also emphasizes the vital necessity of further wild bee population studies, not only in Nova Scotia but in other fruit-growing sections of Canada as well.

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[1] Dominion Apiarist.

REFERENCE

1. Dominion Department of Agriculture, Bulletin No. 162, New Series.

ACTION THERAPEUTIQUE DES POMMES

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Deux articles parus, l'un dans la Revue Française de Pédiatrie en avril 1931, et l'autre dans la Presse Médicale du 25 juin 1932, m'ont donné l'occasion d'étudier un peu de littérature concernant le traitement par les pommes crues des affections gastro-intestinales, et m'ont incité à faire une expérience loyale et personnelle. Il ne m'a pas été possible d'embrasser tout le domaine où la cure est indiquée, pourtant je suis déjà arrivé par un certain nombre d'observations, que je continue encore, à des résultats remarquables et en partie nouveaux pour moi. Ayant adopté, depuis le commencement d'août, ce traitement par les pommes crues, je n'ai que des louanges pour cette méthode.

Simple, elle est bien accueillie par les malades au-dessus d'un an dont elle flatte le goût. Elle leur épargne des diètes hydriques et, tout en satisfaisant leur gloutonnerie, leur assure néannoins un soulagement rapide et appréciable; je pourrais ajouter: toujours une guérison complète. Grâce à ces avantages, ce mode de traitement a incontestablement acquis un droit de cité dans ma thérapeutique des diarrhées.

Voici en quelques mots quelle est l'origine de ce traitement et en quoi il consiste. Durant la guerre, des soldats atteints de dysenterie remarquèrent par hasard l'action thérapeutique fort inattendue des pommes crues. Un médecin practicien de Koenigsfeld, nommé Heilser, vérifia dans sa clientèle les effets excellents de cette cure empirique, et publia ses observations dans un livre en 1928, puis dans une communication au Congrès de Stockholm. Cependant la véritable consécration officielle de la méthode est due au Prof. Moro—allemand—qui l'a employée avec des succès étonnants chez un grand nombre d'enfants atteints d'affections variées, aigues ou chroniques, alimentaires ou infectueuses du tube gastro-intestinal.

Les résultats de Moro furent depuis confirmés de différents cotés en Allemagne d'abord, puis en Roumanie, au Danemark et plus récemment en France. Le régime de Moro est facile à mettre en oeuvre. Il consiste en une absorption exclusive pendant 24 à 48 heures d'une purée de pommes crues, faite avec des pommes mûres, molles, pelées, débarassées des pépins et de leur enveloppe, et râpées sur une râpe en verre. Mes deux premiers cas, au début du mois d'août, ont été traités avec des pommes plutôt vertes et acides. L'application de la méthode ne comporte aucune préparation préalable, pas de lavement, pas de purgation, pas de diète hydrique, pas de médicaments, si ce n'est dans les cas de grande déshydratation où l'on peut injecter sous la peau un sérum sucré ou salé. La quantité de pommes à administrer varie selon l'âge, l'appétit de chacun; on peut atteindre 500 à 1500 grammes par jour, soit 7 à 20 pommes de grosseur moyenne. Plus les malades absorbent de pommes, plus la guérison est rapide. J'ai dans mes observations un petit malade guéri après un premier repas de 250 grammes. Au bout de 36 heures de traitement, nous avons dû donner un lavement pour libérer son intestin. Pourtant ce malade avait une histoire de diarrhée de 7 à 8 selles par jour depuis 5 jours.

Au cours du traitement nous autorisons un peu d'eau ou de thé léger si le malade a soif. Ordinairement, après 12 à 24 heures les selles deviennent plus rares, plus consistantes, plus homogènes, moins fétides, présentant la même apparence microscopique que la compote qui a été absorbée.

Le nombre de selles tombe, de 10 à 15, à 1 ou 2 en 24 ou 48 heures après l'ingestion du premier repas, et la fièvre tombe dans les 48 heures.

Le 3e jour, alors que les fonctions intestinales sont redevenues normales, il faut bien surveiller le régime de transition. C'est là le temps délicat de la cure, en clientèle surtout, La plupart des auteurs interdisent le lait, les légumes (excepté les pommes de terre en purée) et permettent le cacao à l'eau, les biscuits secs, le pain rassis, la viande maigre; et chez les plus jeunes, le babeurre non sucré, le lait albumineux.

Pour ma part, j'ai toujours repris l'alimentation avec des pommes de terre pilées et des biscuits secs pour 48 heures, avant de donner la diète normale selon l'âge. Pour une fois que j'ai manqué à cette règle, j'ai eu une récidive, probablement due à une reprise trop précoce du régime normal. Je citerai cette observation dans un instant.

Sur 21 malades que j'ai traités à l'hôpital, il n'y a aucun accident qui puisse être attribué aux pommes. J'ai eu deux échecs; le premier était un cas de gastro-entérite, secondaire à une congestion pulmonaire et à une otite double suppurée chez un enfant de 10 mois. L'autopsie a, en plus, révélé une méningo-encéphalite. L'autre échec a été chez un enfant de 6 mois, pesant 9 livres, très déshydraté, qui est mort 36 heures après son entrée à l'hopital. Cet enfant n'a d'ailleurs ingéré que 75 grammes de pommes en 2 repas.

A la suite de ce dernier échec, et étant donné la grande difficulté à faire accepter la diète Heisler Moro chez des enfants au biberon, je n 'ai appliqué le régime que chez des enfants de 10 mois et plus. Mes plus beaux succès ont surtout été obtenus chez des enfants de plus d'un an, chez lesquels j'ai pu strictement observer les prescriptions originales de Moro: 2 jours exclusivement à la purée de pommes.

Pour illustrer les bons effets du régime Heisler Moro, permettez-moi de faire un très court résumé de 3 observations:

L'enfant L., no. 34877, agée de 14 mois, est aménée à l'hôpital le 4 nov. 1932, présentant depuis 4 jours, 13 à 14 selles par 24 heures. Ces selles étaient liquides, infectes, avec grumeaux blancs. Elle vomissait même l'eau depuis 24 heures. On parvient à peine, aux deux premiers repas, à lui faire ingérer 75 des 150 grammes prescrits pour chaque repas. Cependant l'enfant devient plus gaie et accepte au complet tous les autres repas. La première selle liquide, glaireuse, infecte survient 3 heures après le 1er repas. Dix-huit heures plus tard une seconde selle pâteuse, épaisse, infecte, sans glaire. Les jours suivants jusqu'à sa sortie, le 2 novembre, l'enfant n'a présenté qu'une ou deux selles normales par jour. Après 48 heures de cure aux pommes la transition au régime normal s'est opérée, d'abord avec des pommes de terre pilées et des biscuits secs.

2e. observation:—L'enfant J.P., 18 mois, hospitalisé le 3 septembre pour prolapsus du rectum, présente le 25 septembre, à la veille de son congé, une diarrhée profuse de 7 à 8 selles par jour. Le 27 septembre, je prescris, sans

aucun succès, une diète lactée, avec des ferments lactiques. Deux jours plus tard, une diète lactée mitigée avec une préparation bismuthée n'a pas plus de succès. Le 7 octobre, j'institue la cure de pommes. Bien que l'enfant n'ait absorbé que 400 grammes par 24 heures, il n'a donné que deux selles durant les 48 heures de cure. La reprise d'une alimentation lactovégétarienne, sans autre transition, me ramène les mêmes troubles qu'avant la cure. Le 17 octobre, le reviens à la pomme crue, avec 200 grammes par repas—4 repas en 24 heures, tous bien absorbés. Cette fois la guérison se maintient après un régime de transition, avec des pommes de terre pilées—jusqu'à sa sortie le 23 octobre 1932.

3e. observation:—L'enfant T., 17 mois, 33853—entre à l'hopital vers les 4 heures de l'après-midi le 2 août 1932. Les parents nous l'amènent parce qu'elle donne, en moyenne, 12 selles vertes, liquides depuis 4 jours. Elle vomit tout ce qu'elle prend depuis 24 heures et aurait eu des convulsions quelques heures avant son entrée à l'hopital. Au cours de la nuit, malgré une diète hydrique absolue, cette enfant émet encore 5 selles liquides. A 10 heures, le matin, elle prend avec avidité les 150 grammes de pommes prescrits pour chaque repas. Il est à remarquer qu'à cette époque, le 3 août, les pommes étaient plutôt vertes. Pourtant notre petite malade a très bien accepté ses 4 repas par jour, nous donnant le même succès que dans les observations précédentes, puisqu'elle n'a donné que deux selles, durant les premières huit heures qui ont suivi le premier repas de pommes. Jusqu'à sa sortie, le 13 août 1932, l'enfant n'a émis qu'une ou deux selles par 24 heures. Après 48 heures de cure, je suis revenu au régime normal avec une transition aux pommes de terre pilées et biscuits secs.

En clientèle j'ai éprouvé un peu de difficulté à mettre ce régime en oeuvre; car les parents s'effraient d'une cure si paradoxale chez les diarrhéiques. Chez les nourrissons il est difficile de faire absorber à la cuillère la quantité de pommes voulue. De plus Wolff signale que toutes les pommes ne possèdent pas les mêmes vertus curatives, en particulier, que les pommes Gravenstein, malgré la qualité de leur saveur, conviennent mal pour le traitement. Enfin, vous comprenez qu'il n'est pas toujours facile d'obtenir en toute saison et à bon compte la quantité voulue de fruits frais. D'après A. Monzon pour parer à ces inconvénients beaucoup d'auteurs européens utilisent une poudre de pommes désséchées dans le vide, qui garde intégralement toutes les vertus curatives du fruit frais, ainsi que sa saveur, et qui peut se conserver longtemps et s'émulsionner dans n'importe quel liquide tiède. Cette poudre connue en Allemagne sous le nom d'"APLONA" permet un dosage plus facile que la pomme en nature. Sa valeur nutritive est de 600 calories pour 100 grammes de poudre et représente 10 fois son poids de pommes fraîches. Ici à Montréal nous avons eu beaucoup de difficultés à obtenir cette poudre mais grâce au travail du Docteur Georges Baril, chef du laboratoire de chimie de l'Université de Montréal on m'a remis une certaine quantité de cette poudre que j'utilise actuellement dans l'un des services de l'Hopital Ste-Justine. Ceci me permet d'appliquer la méthode avec plus de facilité et de succès chez les nourrissons de 2 ou 3 mois. Il suffit de diluer une cuillerée à thé de poudre dans un biberon de 100 grammes d'eau bouillie ou d'eau de riz, renouveler 6 fois par jour et notre petit malade est soumis à la cure aux pommes. J'ai actuellement trois petits nourrissons de 4 et 5 mois qui ont bénéficié de cette

cure, là ou la thérapeutique habituelle avait échoué. L'aspect des selles est exactement le même que chez ceux qui ont suivi la cure aux pommes râpées.

Maintenant si tous les auteurs sont d'accord sur les faits thérapeutiques, l'interprétation est l'objet de nombreuses divergences. Moro prétend que l'acide tannique formerait une membrane de précipitation qui protégerait la muqueuse intestinale contre les irritants . En plus, cette membrane diminuerait l'excitabilité de la muqueuse, et ralentirait le transit. Heisler pense que la pomme, à cause de son acidité, modifierait la flore intestinale. L'un et l'autre de ces auteurs admettent une action mécanique. Le gonflement du bol fécal constituerait une masse spongieuse qui nettoierait mécaniquement, comme un tampon, la lumière intestinale, et qui en absorberait les éléments toxiques. Malyoth fait intervenir la pectine qui existe dans les pommes, dans la proportion de 5%. Cette pectine neutraliserait dans de très fortes proportions les acides et les bases. Enfin, on peut se demander si la production continue des ferments digestifs n'est pas un avantage de la cure par les pommes car elle ne constitue pas un régime de jeûne.

Pour terminer, je dois dire que ce n'est pas une panacée. La cure agit merveilleusement dans beaucoup de cas, seulement il y a des dangers, car il y a toujours une chute du poids, et Moro rapporte un accident mortel, dû à une déshydratation avec défaillance cardiaque. Je me permettrai peut-être de revenir un peu plus tard sur la même question avec des observations chez des nourrissons de 2 mois à 1 an, en y associant des examens coprologiques et bactériologiques assez détaillés.

RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

L'Inflation au Secours de l'Agriculture. W. M. Drummond, Université de Toronto, Toronto, Ont.

Diverses théories sur la cause de la dépression actuelle sont présentées par l'auteur qui discute particulièrement la théorie monétaire. Différents types d'inflation sont décrits. L'auteur fait remarquer qu'une inflation aboutissant à la parité avec la livre anglaise, bien qu'ayant quelque valeur, ne serait pas d'un tel secours que l'agriculture en deviendrait prospère. L'inflation peut dans une certaine mesure améliorer les choses, mais des remèdes allant plus au fond de la question sont nécessaires.

La Situation dans les Provinces de la Prairie en ce qui concerne les Semences de Plantes fourrageres. C. M. Stewart, Dominion Seed Branch, Calgary, Alta.

L'auteur donne tous les renseignements disponibles sur les importations et les exportations du Canada en semences de plantes fourragères. Il discute la production des semences dans les provinces de la Prairie. Cette production pourrait être augmentée dans certains districts et les plantes fourragères pourraient occuper une plus grande partie de l'étendue cultivée sans qu'il soit besoin de recourir à de grosses importations de semences.

Effet de la Recolte a differents Stages de Maturite sur le Rendement et la Composition chimique de l'Orge. D. M. McLean, Collège d'Agriculture du Manitoba, Winnipeg, Man.

La récolte d'orge O. A. C. 21 n'a produit de diminution importante ni dans le rendement ni dans le poids par cent grains. L'auteur indique les variations de com-

position des différentes parties de la plante au fur et à mesure que la plante s'approche de la période de maturité. Le pourcentage de cendre dans le feuillage et la plante-échantillon intégrale tend à décroître à mesure que la plante atteint son degré de maturité, tandis que dans les bourgeons une croissance du pourcentage, suivi d'une période de teneur en cendre uniforme jusqu'à la 18ème journée, puis d'une diminution du pourcentage jusqu'à la période de maturité, est observée. La décroissance dans les tiges se continue jusqu'à la 24ème journée pour augmenter ensuite jusqu'à maturité. Une réduction progressive dans le pourcentage de protéine dans le feuillage et les tiges se produit jusqu'à maturité. Dans les bourgeons le pourcentage de protéine décroît jusqu'à ce que le grain ait atteint l'état de pâte molle, puis une légère augmentation a lieu. Le pourcentage de sucs (reducing sugars) s'accroît dans le feuillage atteignant leur maximum au temps où le grain a atteint l'état d'une pâte solide, et dans les tiges et les bourgeons jusqu'à l'état laiteux, avec ensuite une décroissance rapide jusqu'à la période de maturité dans les trois cas. La teneur maximum en sucrose dans les tiges et les bourgeons est atteinte alors que le grain est à l'état laiteux, c'est-à-dire 14 jours après l'éclosion, tandis que dans le feuillage il ne l'est qu'environ une semaine avant que le point culminant ait été atteint dans les tiges et les bourgeons. La tendance générale du pourcentage d'amidon dans les bourgeons montre une croissance rapide alors qu'approche la période de maturité, tandis que dans le feuillage et les tiges une augmentation s'accuse dans la période finale de maturation et de dessication.

Susceptibilite relative des Plantes cultivees et des Plantes sauvages a la Rouille lineaire dans l'Alberta. G. B. Sanford et W. C. Broadfoot, Laboratoire fédéral de pathologie végétale, Université de l'Alberta, Edmonton, Alta.

Les auteurs donnent des chiffres obtenus aux champs d'expérimentation sur la rouille distribués à travers toute la province. Ils donnent également une liste des plantes attaquées. Les variétés de blé Marquis, Reward et Garnet, qui sont celles cultivées dans l'Alberta, sont pratiquement résistantes à cette rouille à l'heure actuelle.

Quelques moutardes recemment observees. Herbret Groh, Ferme Expérimentale Centrale, Ottawa, Ont.

Une fonction importante du Service d'Inspection des Mauvaises Herbes attaché au Service de Botanique de la Ferme Expérimentale Centrale à Ottawa est de découvrir les nouvelles mauvaises herbes qui peuvent apparaître et d'attirer l'attention sur elles. L'auteur attire particulièrement l'attention dans cet article sur la Moutarde des Chiens, *Erucastrum gallicum*. Cette moutarde a été observée à Sherbrooke, Kenogami et Arvida, P.Q.

Yarovisation ou Vernalisation des Cereales. F. Gfeller, A. G. O Whiteside et R. A. Derick, Ferme Expérimentale Centrale, Ottawa, Ont.

A la suite de travail expérimental effectué par un producteur de semences ukrainien nommé Lyssenko, des essais ont été faits pour hâter la maturité du blé d'hiver en trempant les grains dans l'eau jusqu'à ce qu'ils gonflemt de façon appréciable, c'est-à-dire pendant environ 16 heures, puis en les laissant à l'obscurité pendant 6 à 30 jours à une température de 28 à 40°F. Du blé d'hiver Kharkov trempé puis gardé à l'obscurité pendant 31 jours à 40°F est venu à maturité beaucoup plus rapidement que de la semence non traitée. Des expériences sont en cours à Ottawa à l'heure actuelle.

CONCERNING THE C.S.T.A.

WORLD'S GRAIN EXHIBITION AND CONFERENCE

As we go to press the World's Grain Exhibition and Conference is nearing its official opening. It appears that faith in the undertaking will be fully justified. An elaborate Exhibition and an excellent Conference are in prospect. The recent rise in the price of wheat has aroused optimism in the West and the world interest in whole wheat situation gives increased importance to the discussions which will take place. The various inte ests concerned in the production and distribution of grain will present their findings and opinions in over two hundred papers.

The C.S.T.A. Convention will be held on Monday, July 24th. The programme will be included in the Grain Show programme. Joint sessions of the Grain Conference and the C.S.T.A. and its affiliated groups and societies will take place during the two weeks, July 24 to August 4. The Exhibition and Conference will be formally closed by His Excellency, Lord Bessborough, on Friday afternoon, August 4th.

NOTES AND NEWS

J. E. Lemire (Montreal '17) has been transferred from D'Israeli to become Agronome-Régional at Victoriaville, Arthabaska County, P. Q.

Ls. Emile Boutin (Laval '31) has been transferred to Pierreville, Yamaska County, P. Q.

Fl. Champagne (Laval '16) has been transferred from the Department of Agriculture, Quebec to Ste. Anne de la Pocatière, P. Q.

Gerard Lemire (Laval '31) has been transferred from Isle Verte to Rimouski, P.Q.

J. H. Tessier (Montreal '25) has been transferred from Pierreville to St. Hyacinthe, P. Q.

F. L. Drayton (McGill '14) who has been working under a United States National Research Fellowship in the Biological Laboratories of Harvard University has returned to the Division of Botany, Central Experimental Farm, Ottawa.

Ubald Pilon (Laval '31) has been transferred from Amos to Macamic, P. Q.

John Keay (Saskatchewan '31) has returned from post-graduate work at the Iowa State College at Ames and is located at 420 Stadacona Street West, Moose Jaw, Sask.

Wm. Ferguson (McGill '31) is now located at the Horticultural Division, Central Experimental Farm, Ottawa.

R. E. English (Alberta '28) is located at Fleet, Alberta.

R. W. Ward (Acadia '32) who has been doing post-graduate work at Harvard University has now returned to the Laboratory of Plant Pathology, Kentville, N. S.

Gustave Gaudet (Laval '22) has changed his office location from Chatham, N. B., to Caraquet, N. B.

F. N. Hewetson (British Columbia '33) is now located at the Dominion Experimental Farm, Summerland, B. C.

Geo. Belanger (Laval '33) is now located at St. Alexandre, Kamouraska County, P. Q.

Hugh M. Thompson (British Columbia '33) is now located at Chilliwack, B. C.

Edgar Hilton (McGill '34) was drowned while swimming in the Rideau Canal at Ottawa. He was in his fourth year at Macdonald College where he was a very popular and promising student. Members of the Society extend their sympathy to his parents of Carleton, Yarmouth County, N. S. Edgar Hilton was a nephew of Dr. E. S. Archibald, Director of Dominion Experimental Farms, Ottawa, and also Dr. M. Cumming, N. S., Department of Agriculture, Halifax, and a brother of Smith Hilton, Assistant Superintendent, Dominion Experimental Farm, Nappan, N. S. This unfortunate accident removes one of the most promising of the younger men in technical agriculture.